GALILEO

Intelligent Ventilation

GALILEO Service Manual including Maintenance, Repairs and Tests

PN 610207/05

Software versions 1, 2 & 3

October 31, 2005

HAMILTON MEDICAL

Manufacturer
HAMILTON MEDICAL AG
Via Crusch 8
CH-7402 Bonaduz
Switzerland
Phone: (+41) 81 660 60 10
Fax: (+41) 81 660 60 20
E-mail: techsupport@hamilton-medical.ch
International Web Site: www.hamilton-medical.com
Partner Web Site: www.hamilton-medical.com/partner-site
Intelligent Ventilation Website: www.IntelligentVentilation.org

Representative in USA
HAMILTON MEDICAL Inc.
4990 Energy Way
Reno, NV 89502
PO Box 30008
Reno, NV 89520
Phone: (775) 858-3200
Toll-free: (800) HAM-MED 1
Or: (800) 426-6331
Fax: (775) 856-5621
E-mail: marketing@hammed1.com
International Web Site: www.hamilton-medical.com
Partner Web Site: www.hamilton-medical.com/partner-site
Intelligent Ventilation Website: www.IntelligentVentilation.org

Contents

Part 2:
Preventive maintenance and testing

Part 3: Component details, repairs, and troubleshooting

Part 4: Appendixes

Conventions

Notes, Cautions and Warnings

Note
This format emphasizes information of particular importance.

CAUTION
This format alerts the user to the possibility of a problem with the device associated with its use or misuse, such as device malfunction, device failure, damage to the device, or damage to other property.

WARNING
This format alerts the user to the possibility of injury, death, or other serious adverse reactions associated with the user or misuse of the device.

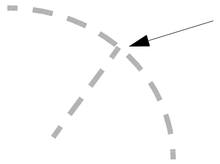
Typographic conventions

Effect	Example	Function
Courier, bold	**`Configuration`**	Marks text quoted directly from the GALILEO or GALILEO Gold screen.
Italic	*GALILEO Gold Intensive Care Ventilator Operator's Manual*	Marks the names of other documents.
	Appendix C, *Upgrade paths*, on page C-1	Marks text that is a quotation from within the manual. In this example, it is part of a cross-reference.
	Tank	Marks a term that is in the glossary. If you are using a PDF file to view this, you can hyperlink to the glossary by clicking on these items.
Bold	**TRIGGER**	Marks text that is quoted directly from: • The GALILEO case • A touch key • A printed circuit board
Bold, italic	Select ***only the first*** column.	Emphasizes important text.

Expressions

Expression	Example	Explanation
Activate	Activate **`LED On/Off`**.	Using the control knob, you must first select the **`LED On/Off`** button on GALILEO's screen, and then press the control knob. The button on the screen changes its appearance, so that it looks "pressed". It now performs its function (turning the LED on in this case). Sometimes you are told to "activate and set" a field. In this case you first activate the field, and then turn the P&T-knob to set a value.
Deactivate	Deactivate **`LED On/Off`**.	With **`LED On/Off`** still selected and activated, you must press the control knob again. The button on the screen changes its appearance, so that it looks "unpressed". It stops performing its function (turning the LED off).
Pressure	Pressure in the tank is 200 to 340 mbar.	This expression refers to that part of the pressure that is above the ambient pressure. Therefore, if we say that pressure in the tank is 200 to 340 mbar, we mean it is 200 to 340 mbar above the pressure in the room in which the GALILEO is placed.
Software version	... software version GMP 3.41f...	GALILEO contains a number of memory devices that hold software. The software in each device is identified by its version number. However, it is the software version of the GMP (GALILEO Main Processor) that is the most critical, and that is therefore quoted as denoting the software version of the GALILEO.
Update	This kit enables you to update to software version 3.3.	This expression refers to an improvement or improvements to existing functions. Updates can involve both hardware and software. Software updates are generally denoted in the software revision number by an increment in a digit after the decimal point: for example, GMP 03.10a to GMP 03.31c.
Upgrade	This kit enables you to upgrade to software version 3.	This expression refers to the addition of new functions to a device. There are three ways you can do this: • You can add a hardware item that offers additional functions. • You can upgrade to a higher software revision. This is indicated by a higher value before the decimal point: for example, GMP 02.12a to GMP 03.41f. • You can upgrade to a higher type of software. For instance, you can upgrade from "Classic" to Gold software, as in the upgrade from GMP 03.41f "Classic, to GMP 03.41f Gold.
*	With this kit, you can update or upgrade from software version GMP 1.*, 2.*, or 3.* to GMP 3.41f.	Unless otherwise locally defined, a syntactic variable ("wild card") denoting any number of any alpha-numeric characters.

Graphics

Effect	Explanation
	Indicates tubing that is not a part of GALILEO, but that you must provide as part of your test equipment. The junction (indicated with an arrow) can be a T-piece. For details of the tubing and T-pieces you can use, see Appendix A.3.6, *Test equipment*, on page A-3.

Foreword

Who is this manual for?

This manual is for engineers who have successfully completed a HAMILTON MEDICAL AG Service Training Course for GALILEO ventilators. If you have not completed such a course, and are therefore not authorized to undertake the maintenance, repairs and tests described in this manual, use the *GALILEO Service Manual* (PN 610206) instead.

Training courses are held regularly in Bonaduz, Switzerland, at HAMILTON MEDICAL's headquarters, and at other locations throughout the world. For more information, see the training section of the HAMILTON MEDICAL AG International Web Site (http://www.hamilton-medical.com). Alternatively, see the training section of the HAMILTON MEDICAL AG Partner Web Site (http://www.hamilton-medical.com/partner-site).

Note

If you have questions about any aspect of testing or about any part of this manual, do not hesitate to contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

What does this manual contain?

This manual includes the contents of the *GALILEO Service Manual* (PN 610206). This material describes the architecture and components of GALILEO.

In addition, this manual also contains information on testing, troubleshooting and repairing GALILEO. There are also some additional appendixes.

For full details of the structure of this manual, see *How is this manual structured?* on page *Foreword-2*.

What does this manual not contain?

This manual does not contain information about operating GALILEO. For operating instructions, see the *GALILEO Intensive Care Ventilator Operator's Manual* (PN 610175), or local language equivalent.

This manual does not contain much information about board-level logic or functions. ***This is because HAMILTON MEDICAL AG does not permit board-level repairs, or any repairs at a lower level than the parts provided in Appendix H, Spare parts.***

This manual does not contain the appendix dealing with upgrade routes that was included in earlier versions. You can find the latest information about upgrade and update routes and kits on the HAMILTON MEDICAL AG Partner Web Site (http://www.hamilton-medical.com/partner-site) under the menu item *Updates & Upgrades*.

What equipment does this manual cover?

This manual is for GALILEO software version 3 (Upgrade 2) ventilators. However, in so far as was possible, notes were added for software version 2 (Upgrade 1) and software version 1 (original) GALILEO ventilators. Photographs in this manual deliberately do not always show the latest revisions of components. Where significant differences between revisions exist, we have tried to include alternative photographs.

How is this manual structured?

Section	Function	Your responsibility
Section 1, *Introduction to GALILEO*	This short section explains the theory behind all HAMILTON MEDICAL AG ventilators.	***You must fully understand this section.***
Section 2, *Pneumatics: components and theory of operation*	This section looks at the gas flows, flow measurements and pressure measurements in all the pneumatic circuits in GALILEO.	***You must be able to name and explain the functions of all the major components.***
Section 3, *Electronics: component functions*	This section looks at the physical position and basic functions of all GALILEO's printed circuit boards. There are few details given, because boards cannot be repaired in the field, but must be replaced.	***You must be able to identify all circuit boards, and know where they are positioned in GALILEO.*** It is not necessary to know the detailed function of each board.
Section 4, *Overview of preventive maintenance and testing*	This section gives a schedule for maintenance.	***You must be familiar with the maintenance schedule for GALILEO.***
Section 6, *Engineer preventive maintenance*	This section gives maintenance details.	***You must be able to perform all the tasks in this section.***
Section 7, *Checking hardware, voltages, and interface*	This section lists tests you must perform on GALILEO before you start the test software tests.	***You must be able to use this section to test GALILEO.***
Section 8, *Checking electrical safety*	This section lists further tests you must perform on GALILEO before you start the test software tests.	***You must be able to use this section to test GALILEO.***
Section 9, *Running Original or Upgrade 1 test software* Section 10, *Running Upgrade 2 test software*	This section explains how you perform the tests that are built into the software in GALILEO. There are two versions of the software.	***You must know how to perform all the tests appropriate to your ventilator.***
Section 11, *Component details and replacement procedures*	This section complements Sections 2 and 3 by giving much more information about all the major components in GALILEO. The section also explains how to replace or maintain each major component.	***You must be able to use this section to make repairs***.
Section 12, *General troubleshooting*	This section explains several methods for solving technical problems with GALILEO.	***You must be able to use this section to solve technical problems.***
Appendix A, *Maintenance tools and test equipment*	This appendix lists the equipment you require to work on GALILEO.	Check this appendix to make sure you have the correct tools and test equipment.
Appendix B, *Communication interface specifications*	Information resource.	You might require this information if fitting a communication interface to GALILEO.
Appendix C, *GMP software/hardware compatibility*	Information resource.	You only require this section if you have compatibility problems.

Section	Function	Your responsibility
Appendix D, *Software revisions, features and compatibility*	Information resource.	You only require this section if you must supply customers with historical information about GALILEO.
Appendix E, *Hardware revisions, features, and compatibility*	Information resource.	You only require this section if you have compatibility problems.
Appendix F, *Historical and background notes*	Information resource.	This information is of interest only.
Appendix G, *Automated electrical safety tests*	Gives an overview of performing EST using automated equipment. Details will vary depending on the equipment you have.	Use this section if appropriate. For more information, see Section 8, *Checking electrical safety*, on page 8-1.
Appendix H, *Spare parts*	Information resource.	You only require this section when you must order spare parts.
Appendix I, *Schematics*	This section includes many of the schematics produced by HAMILTON MEDICAL AG for internal use.	You are sometimes directed to this section when reading in other parts of the manual.
Appendix J, *Glossary*	Information resource. This section explains many of the expressions used in the rest of the manual.	You must know to find information in this section.
GALILEO Original and Upgrade 1 Test Report *GALILEO Upgrade 2 Test Report*	Report sheets for the two test software sections.	***You must:*** • ***Select the report you require.*** • ***Photocopy the report.*** • ***Complete the report when using the test software tests.***

Part 1:
General description

Section
1 Introduction to GALILEO

1.1 What is GALILEO?

GALILEO is a HAMILTON MEDICAL AG ventilator suited to use in an intensive care environment.

1.2 What does GALILEO do?

In common with all HAMILTON MEDICAL AG ventilators, GALILEO supplies a regulated flow of an air/oxygen mixture to a patient suffering a compromised ability to breath.

1.3 How does GALILEO function?

At its simplest, GALILEO functions by regulating the flow of gases at three points, as represented in the diagram in Figure 1-1.

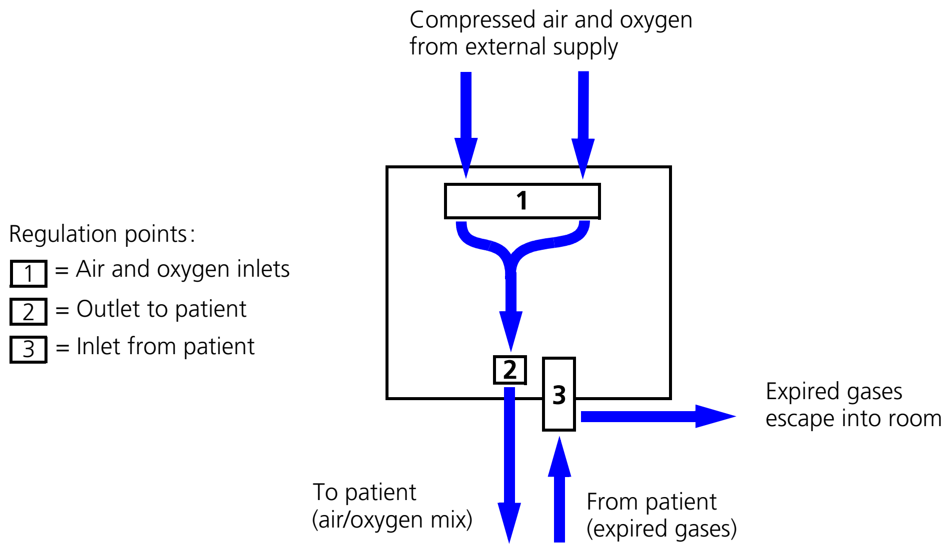


Figure 1-1. Principle gas flow through GALILEO

Compressed air and oxygen are supplied to GALILEO from an external supply. The flow of these gases are then regulated at three points:

- Air and oxygen inlets (regulation point 1)
- Outlet to patient (regulation point 2)
- Inlet from patient (regulation point 3)

Expired gases from the patient are allowed to escape into the room.

In this manual, we refer to this gas flow to GALILEO, then to the patient, and then back through GALILEO to the room, as the “principle gas flow”.

1.4 What components manage the principle gas flow?

The main components that control the flow of gases through GALILEO are shown in Figure 1-2.

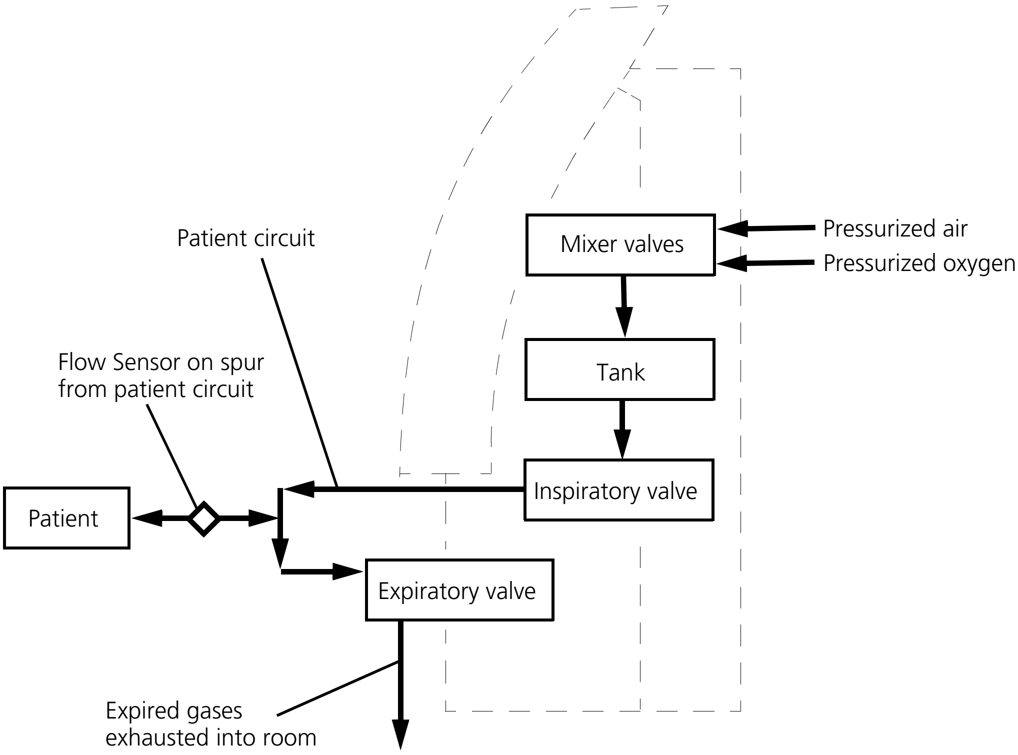


Figure 1-2. Components comprising principle gas route through GALILEO

The components have the following functions:

- Mixer valves — Regulate the flow of air and oxygen into the ventilator at the air and oxygen inlets.
- Tank — Smoothes the flow of air and oxygen through the ventilator, and provides a place for the gases to mix.
- Inspiratory valve — Regulates the flow of the air/oxygen mixture to the patient.
- Patient circuit — Supplies air/oxygen to the patient, and removes exhalation gases from the patient. Gases move in one direction in the patient circuit.
- Spur — Connects the patient circuit to the patient's airway. Gases flow in both directions, as the patient breathes in and out (inhales and exhales).
- Flow Sensor — Monitors the flow of gases to and from the patient's airway.
- Expiratory valve — Regulates the flow of expiratory gases from the patient to the room in which GALILEO is placed.

1.5 What other components does GALILEO have?

Apart from the components comprising the principle gas route, GALILEO has several other sets of components that offer additional safety or functions. These are:

- Safety valves. There are three of these, as documented in Section 2.4, *Components managing the patient and tank overpressure-relief gas-flows*, on page 2-12 and Section 2.5, *Components managing the ambient state gas flow*, on page 2-14.
- Oxygen cell. This is a Galvanic fuel cell that measures the partial pressure of oxygen in the air/oxygen mixture in the tank. Although GALILEO does not require the cell to determine the mixture, it is very useful for monitoring and safety purposes. For more information, see Section 2.6, *Components monitoring oxygen concentration*, on page 2-18.
- Nebulizer pump. This is an option that, when fitted, enables GALILEO to power an external nebulizer jar. For more information, see Section 2.7, *Components managing the nebulizer gas flow*, on page 2-20.
- Additional pressure measurement capability. GALILEO has an additional pressure sensor to enable the user to measure pressure at a point of his choosing. For more information, see Section 2.8, *Components supporting auxiliary pressure measurement*, on page 2-22.
- Communication interface. This enables GALILEO to communicate with an external monitor, alarm system, or computer. For more information, see Appendix B, *Communication interface specifications*.

1.6 Flow control and pressure control

Some HAMILTON MEDICAL AG ventilators are flow-controlled, and some are pressure-controlled.

A flow-controlled ventilator such as GALILEO measures the flow of gas through the inspiratory valve into the patient circuit, stops the flow after the correct volume of gas has entered the patient circuit, and then opens the expiratory valve to enable the patient to expire.

In a pressure-controlled ventilator such as RAPHAEL, the inspiratory valve and expiratory valve synchronize to increase and decrease the pressure in the patient circuit, thereby causing the patient to inspire and expire. At no time does the expiratory valve completely close.

The advantage of a flow-controlled ventilator is that the flow of air to the patient can be set with great precision. The advantage of a pressure-controlled ventilator is that the pressure in the patient circuit can never become uncomfortably high — for instance if a patient sneezes. Furthermore, the volume of air delivered to the patient can be set with quite high precision.

Section
2 Pneumatics: components and theory of operation

2.1 Overview

This section introduces you to all the gas flows and all the major pneumatic components in GALILEO. In addition, most components are cross-referenced to Section 11, *Component details and replacement procedures*, where they are explained in much greater detail.

Note

The figures in this section show exploded views of GALILEO. It is the nature of exploded diagrams that components are not always shown in their correct positions in the enclosure, nor in their precisely correct positions relative to one another.

2.2 Components managing the principle gas flow

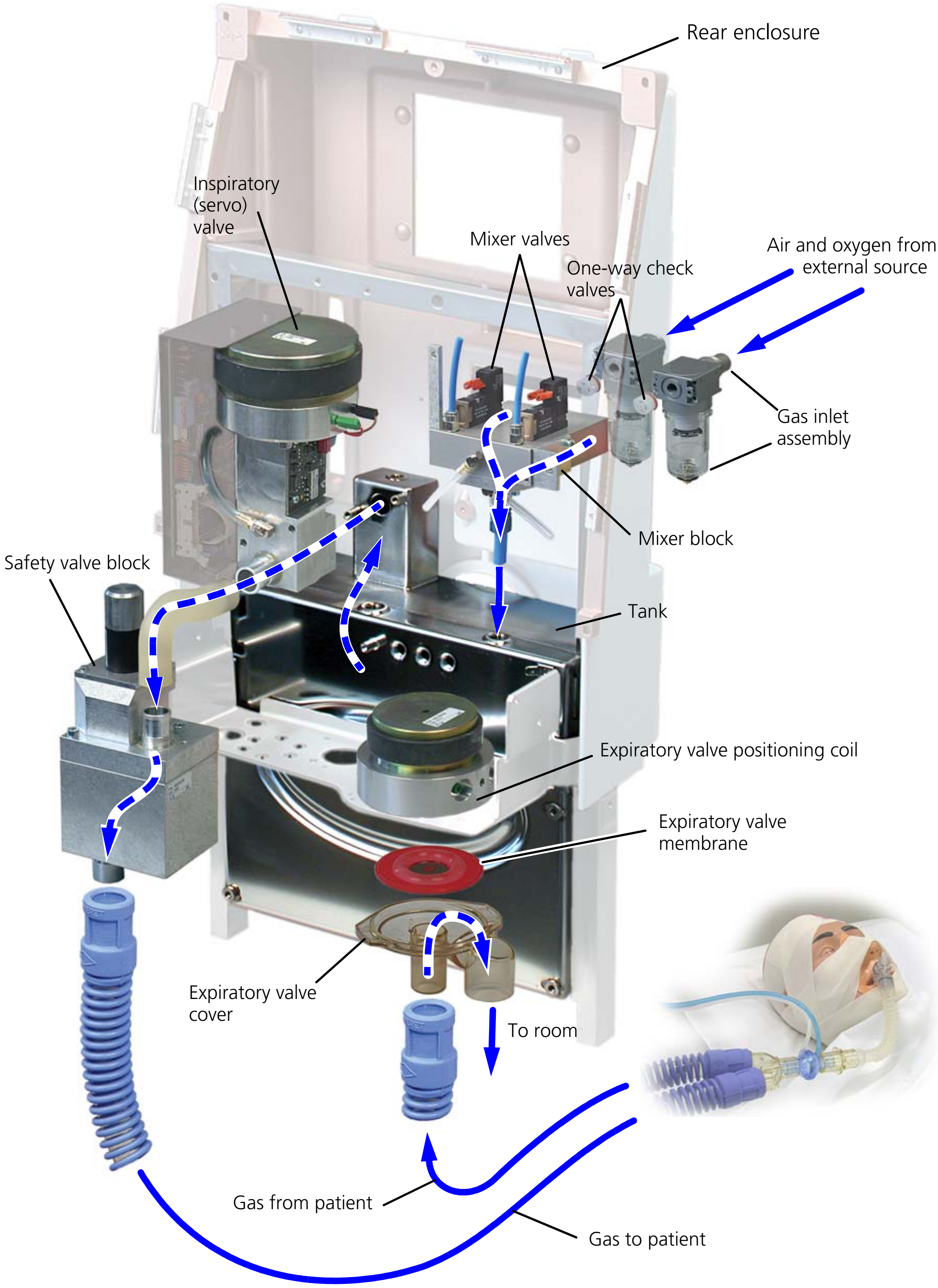


Figure 2-1. Components managing the principle gas flow

2.2.1 Introduction

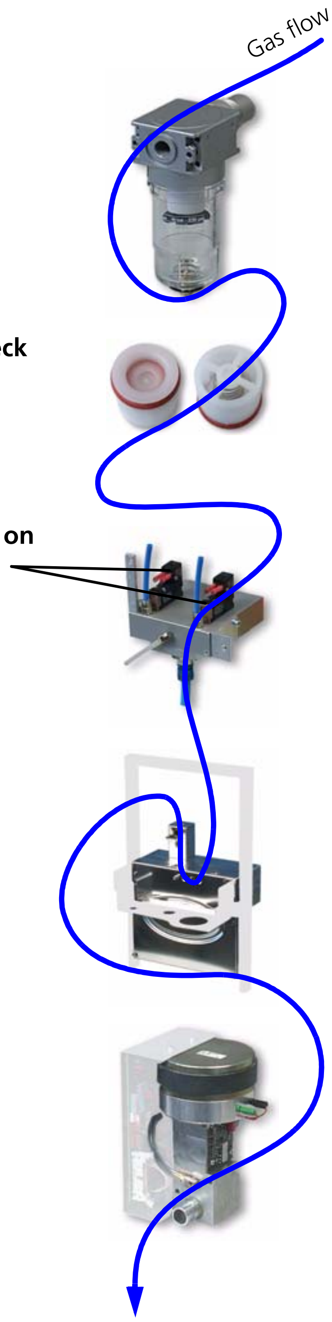
As discussed in Section 1, *Introduction to GALILEO*, the principle gas flow is the flow of oxygen and air into GALILEO, out to the patient, and back through GALILEO to the room.

This flow is managed by components that regulate the gases at three points:

- Air and oxygen inlets to GALILEO
- Gas outlet from GALILEO to patient
- Gas inlet from patient to GALILEO

The following section gives details of the components that manage this principle gas flow.

2.2.2 Components managing principle gas flow



Gas inlet assemblies

- The gas inlet assemblies make a gas-tight connection with the external air and oxygen sources.
- They clean and dry the gas passing through.
- They are fully explained in Section 11.17, *Gas inlet assemblies*, on page 11-89.

One-way check valves

- The check valves ensure that neither air nor oxygen can flow back out of GALILEO into the external source.
- They are fully explained in Section 11.17, *Gas inlet assemblies*, on page 11-89.

Mixer valves on mixer block

- The *mixer valves* control the flow of air and oxygen into GALILEO.
- They are fully explained in Section 11.25, *Mixer block*, on page 11-135.

Tank

- The *tank* is a part of the chassis.
- It provides sufficient volume for the mixing of the air and oxygen.
- It smoothes the flow of mixed gas to the inspiratory valve.
- It is fully explained in Section 11.32, *Tank and flow restrictors*, on page 11-198.

Inspiratory (servo) valve

- The *inspiratory (servo) valve* precisely controls the flow of the air/oxygen mixture from the tank to the patient.
- It is fully explained in Section 11.22, *Inspiratory (servo) valve and servo board*, on page 11-108.

Safety valve block

- The *safety valve block* contains the *ambient valve* and the *patient overpressure valve*.
- It has no function during normal ventilation, except to provide a route for gas flow to the patient.
- It is fully explained in Section 11.7, *Ambient valve and patient overpressure valve*, on page 11-19.

Expiratory valve

- The *expiratory valve* controls the escape of expired gas from the patient circuit.
- It maintains PEEP/CPAP.
- It comprises positioning coil (1), membrane (2), and cover (3).
- It is fully explained in Section 11.13, *Expiratory valve*, on page 11-64.

This page intentionally left empty.

2.3 Components performing principle pressure and flow measurements

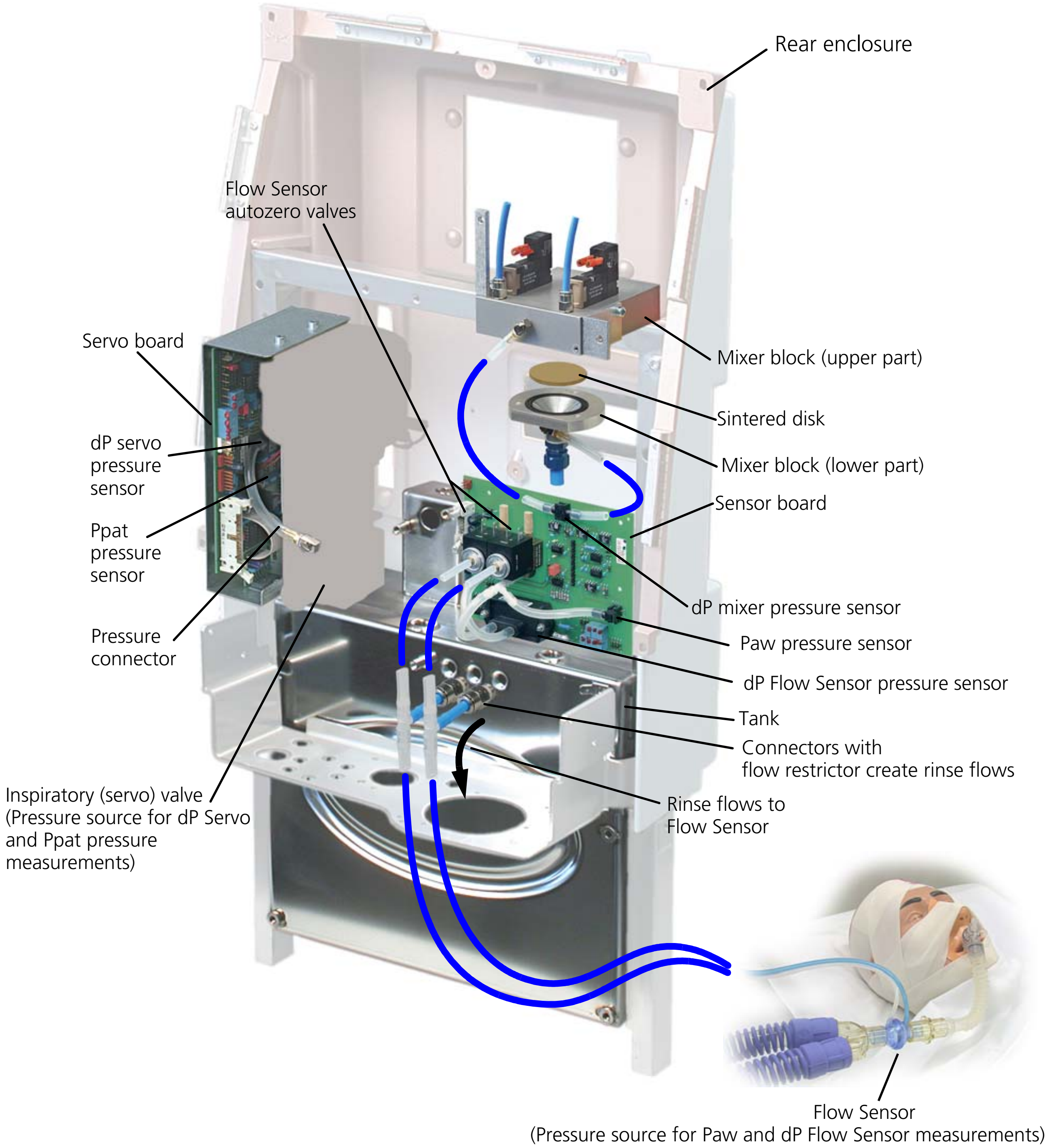


Figure 2-2. Components performing principle pressure and flow measurements

2.3.1 Introduction

To deliver gas to the patient at the correct time, in the correct quantity, and in the correct mixture, GALILEO must be able to measure pressure and flow at a number of points in the principle gas flow. These points are shown in this section.

In addition, GALILEO has one further pressure sensor not shown here. It is the Paux pressure sensor, shown in Section 2.8, *Components supporting auxiliary pressure measurement*, on page 2-22.

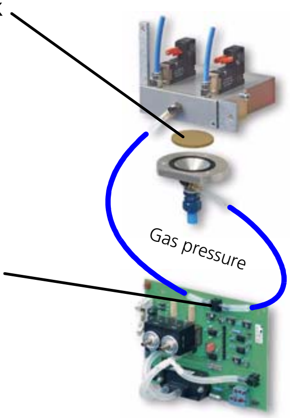
Note

In all cases, GALILEO obtains a value for a gas flow by recording the pressure on each side of a flow restrictor placed in the gas flow, and then calculating the flow value based on the pressure difference between the two sides. There are therefore no devices in GALILEO that measure flow directly; there are only devices that measure pressure.

2.3.2 Components measuring air and oxygen flows to tank

Sintered disk

dP mixer pressure sensor



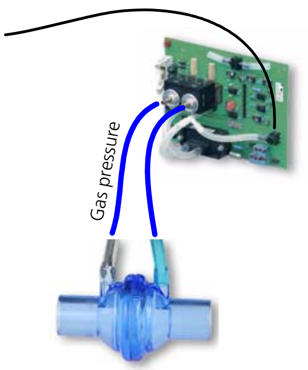
- Acts as a flow restrictor, to create a pressure difference between the upper and lower parts of the mixer block.
- Fully explained in Section 11.25, *Mixer block*, on page 11-135.

- Positioned on the *sensor board*.
- Measures the pressure difference across the sintered disk, enabling GALILEO to calculate the flow of gas that passes through the mixer block to the tank.

2.3.3 Components measuring gas pressure at patient airway

Paw pressure sensor

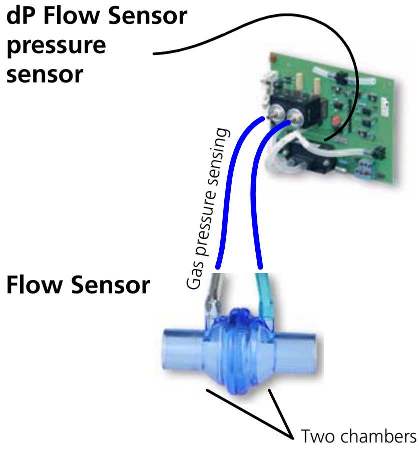
Flow Sensor



- The *Paw pressure sensor* is positioned on the *sensor board*.
- It measures the pressure at the Flow Sensor. (The Flow Sensor is positioned at a point very close (proximal) to the patient airway.)

- Enables GALILEO to measure gas flow to and from the patient, and gas pressure proximal to the patient's airway.
- Fully explained in Section 11.15, *Flow Sensor*, on page 11-77.

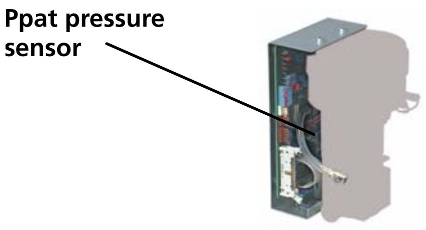
2.3.4 Components measuring gas flow at patient airway



- The *dP Flow Sensor differential pressure sensor* is positioned on the *sensor board*.
- It measures the pressure difference between the two chambers of the Flow Sensor, and enables GALILEO to calculate the flow of gas to and from the patient, at a point very close (proximal) to the patient airway.

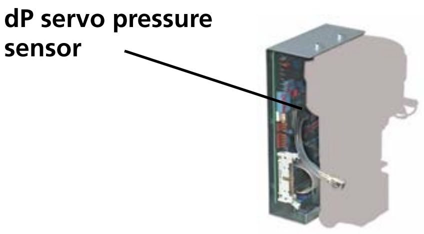
- The *Flow Sensor* enables GALILEO to measure gas flow to and from the patient, and gas pressure proximal to the patient's airway.
- It is fully explained in Section 11.15, *Flow Sensor*, on page 11-77.

2.3.5 Components controlling gas pressure in patient circuit



- The *Ppat pressure sensor* is positioned on the *servo board*.
- It measures the absolute pressure in the patient circuit, as indicated at the inspiratory (servo) valve outflow.

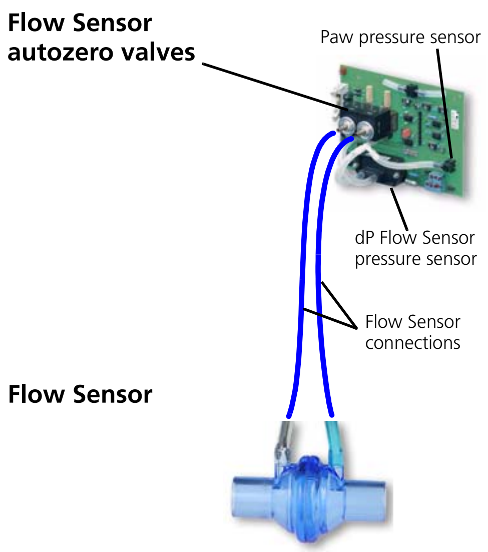
2.3.6 Components controlling gas flow in patient circuit



- The *dP servo differential pressure sensor* is positioned on the *servo board*.
- It measures the pressure difference between the inflow and outflow of the inspiratory (servo) valve. Using this value, together with the known position of the plunger in the valve, GALILEO calculates the flow of gas through the valve to the patient.

2.3.7 Components autozeroing the Flow Sensor

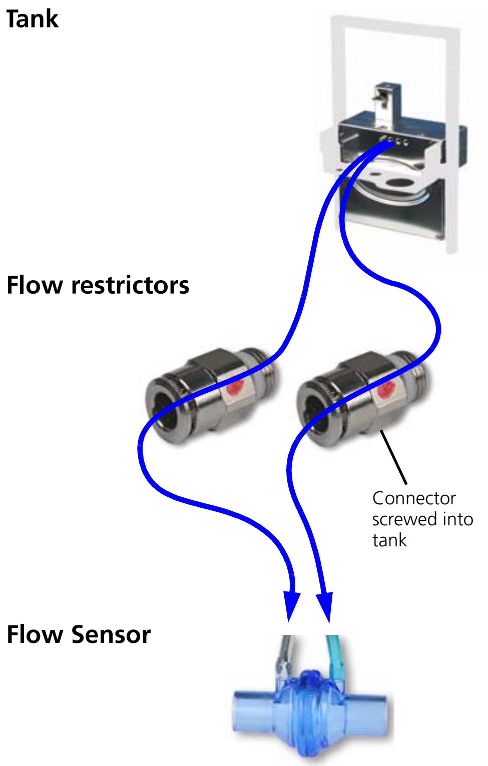
Note
The following process does not change the characteristics of the Flow Sensor. Instead, it enables GALILEO to determine compensation values to apply to the readings from the *dP Flow Sensor differential pressure sensor* and the *Paw pressure sensor*.



- The *Flow Sensor autozero valves* are positioned on the *sensor board*.
- During normal ventilation they open at calculated intervals to bring both Flow Sensor connections to ambient pressure. This enables GALILEO to calculate zero pressure offsets for the *dP Flow Sensor* and the *Paw* pressure sensors. These offsets compensate for the drift in sensor values that takes place with temperature change.
- They are fully explained in Section 11.15.5.3, *Flow Sensor autozeroing*, on page 11-81

- The *Flow Sensor* enables GALILEO to measure gas flow to and from the patient, and gas pressure proximal to the patient's airway.
- It is fully explained in Section 11.15, *Flow Sensor*, on page 11-77.

2.3.8 Components generating the rinse flow



- The tank is a part of the chassis.
- It contains the air/oxygen mix that GALILEO supplies to the patient and also uses for the *rinse flows*.
- It is fully explained in Section 11.32, *Tank and flow restrictors*, on page 11-198.

- The flow restrictors are contained within connectors that are screwed into the tank.
- They allow a constant small flow of gas (25 ml/m, approximately) from the tank, through the blue and clear Flow Sensor tubes, to the Flow Sensor.
- This *rinse flow* minimizes the possibility of tube blockage, and hinders the potential migration of bacteria and viruses from the patient's expired gases through the tubes, towards the ventilator.

- The *Flow Sensor* enables GALILEO to measure gas flow to and from the patient, and gas pressure proximal to the patient's airway.
- It is fully explained in Section 11.15, *Flow Sensor*, on page 11-77.

2.3.9 Overview of pressure sensors

The following table lists all the pressure sensors in GALILEO:

Name	Location	Comment
dP Flow Sensor	Sensor board	Measures differential pressure across the *Flow Sensor*. See also Section 11.31, *Sensor board*, on page 11-192.
dP mixer	Sensor board	Measures differential pressure across the mixer. See also Section 11.31, *Sensor board*, on page 11-192.
dP servo	Servo board	Measures differential pressure across the *inspiratory (servo) valve*.
Paw	Sensor board	Measures pressure at the *Flow Sensor*.
Paux	Sensor board	Measures pressure at an external pressure source. This is documented in Section 2.8, *Components supporting auxiliary pressure measurement*. See also Section 11.31, *Sensor board*, on page 11-192.
Ppat	Servo board	Measures pressure at the *inspiratory (servo) valve* outlet.

Table 2-1. Pressure sensors in GALILEO

Note
You cannot replace or repair sensors individually. You must replace the board on which they are mounted.

This page intentionally left empty.

2.4 Components managing the patient and tank overpressure-relief gas-flows

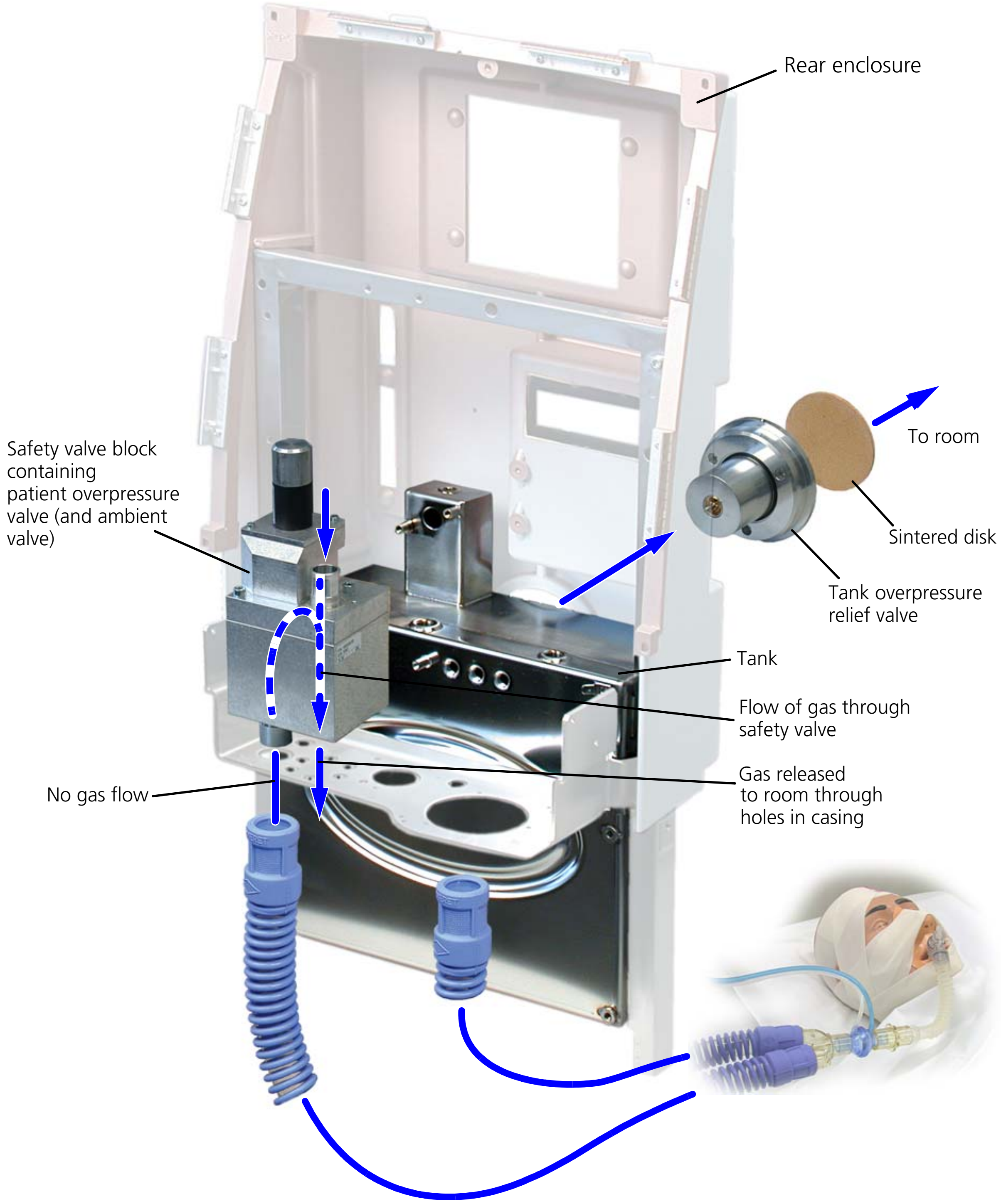


Figure 2-3. Components managing the overpressure-relief gas-flows

2.4.1 Introduction

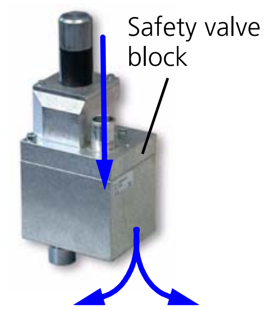
GALILEO incorporates two safety valves to limit the internal gas pressure in event of an electronic or mechanical failure.

The patient overpressure-relief valve limits pressure in the patient circuit. The tank overpressure-relief valve, in the tank. Both are mechanical valves, and are not controlled electronically in any way.

The valve in the tank has a secondary function. When GALILEO must quickly change the ratio of air and oxygen in the mixture in the tank, it flushes the tank with a large volume of the new mixture. This deliberately creates overpressure in the tank, which the tank overpressure-relief valve releases.

2.4.2 Components managing the patient-overpressure-relief gas-flow

Patient overpressure-relief valve

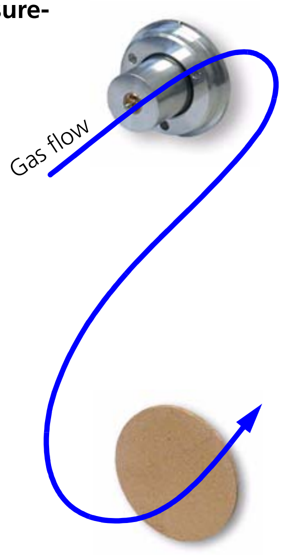


- The patient overpressure-relief valve is positioned inside the safety valve block.
- It prevents the patient breathing circuit from being able to reach pressures of over 100 mbar in the case of GALILEO malfunctioning.
- Gas flows in from the tank.
- Gas flows out through the casing, into the room.
- The valve is fully explained in Section 11.7, *Ambient valve and patient overpressure valve*, on page 11-19.

Note
Do not confuse this valve with the user-adjustable **Pmax** alarm limit implemented in the software.

2.4.3 Components managing the tank-overpressure-relief gas-flow

Tank overpressure-relief valve



- The overpressure-relief valve prevents the pressure in the tank from being able to reach dangerously high pressures in the case of GALILEO malfunctioning.
- It enables GALILEO to flush the tank with a new gas mixture when a user makes a change to the air/oxygen mixture.
- It is fully explained in Section 11.33, *Tank overpressure-relief valve and sintered disk*, on page 11-208.

Sintered disk

- The sintered disk reduces noise from the tank overpressure-relief valve.
- It is fully explained in Section 11.33, *Tank overpressure-relief valve and sintered disk*, on page 11-208.

Note
Do not confuse this sintered disk with the sintered disk in the mixer block that acts as a flow restrictor.

2.5 Components managing the ambient state gas flow

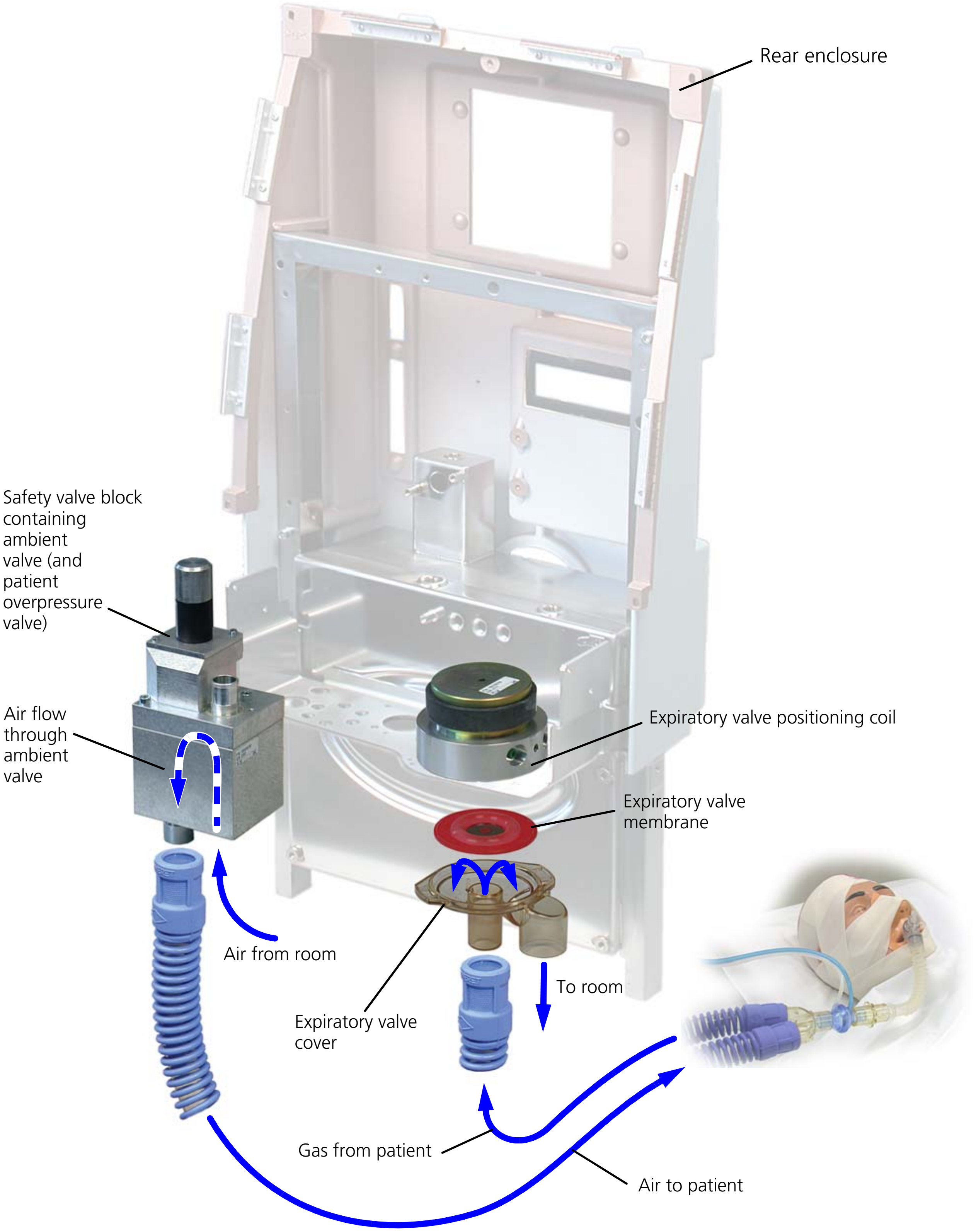


Figure 2-4. Components managing the ambient state gas flow

2.5.1 Introduction

GALILEO uses the ambient state in event of a severe system failure. In the ambient state, the patient is not actively ventilated in any way, but is allowed to inhale through the ambient valve and exhale through the expiratory valve if he or she is able to do so.

In the ambient state, all valves revert to their unpowered status. By design, this is always the status that is safest for the patient.

2.5.2 Components managing the ambient state gas flow

The most important components that manage the ambient-state gas flow are:

Ambient valve

Gas flow from room to patient tubing

Note

The *ambient valve* does not actively aid inspiration. It only allows the patient to inhale if he is able to do so without help.

- The ambient valve is positioned inside the safety valve block.
- When GALILEO is in the ambient state, it switches to its unpowered, on, state.
- When on, the patient can draw ambient air through the safety valve block (but only if he is able to inhale unaided).
- The ambient valve is fully explained in Section 11.7, *Ambient valve and patient overpressure valve*, on page 11-19.

Expiratory valve

Gas flow from patient tubing to room

- When GALILEO in the ambient state, the expiratory valve switches to its unpowered, on, state.
- When on, the patient can exhale freely.
- When on, PEEP/CPAP is not maintained.
- The ambient valve is fully explained in Section 11.13, *Expiratory valve*, on page 11-64.

2.5.3 Overview of valve status in ambient state

In addition to the ambient and expiratory valves, all valves in GALILEO have some effect on the ambient state:

Name	Status	Comment
Ambient valve (in safety valve block)	Opens if patient can draw air through it by inhaling actively and unaided.	Air from the room can flow to the patient.
Expiratory valve	Open	The patient can exhale.
Inspiratory valve	Closed	No gas from the tank flows to the patient.
Mixer valves	Closed	Neither air nor oxygen from the gas inlets can flow into GALILEO.
Nebulizer valve	Closed	No gas from the tank flows to the nebulizer.
Patient overpressure valve (in safety valve block)	Closed	There is no reason associated with GALILEO for this non-electronic, mechanical valve to open, as there can be no overpressure in ambient mode.
Tank overpressure valve (in tank)	Closed	There is no reason for this non-electronic, mechanical valve to open, as there can be no tank overpressure in ambient mode.

Table 2-2. Ambient state overview in GALILEO

This page intentionally left empty.

2.6 Components monitoring oxygen concentration

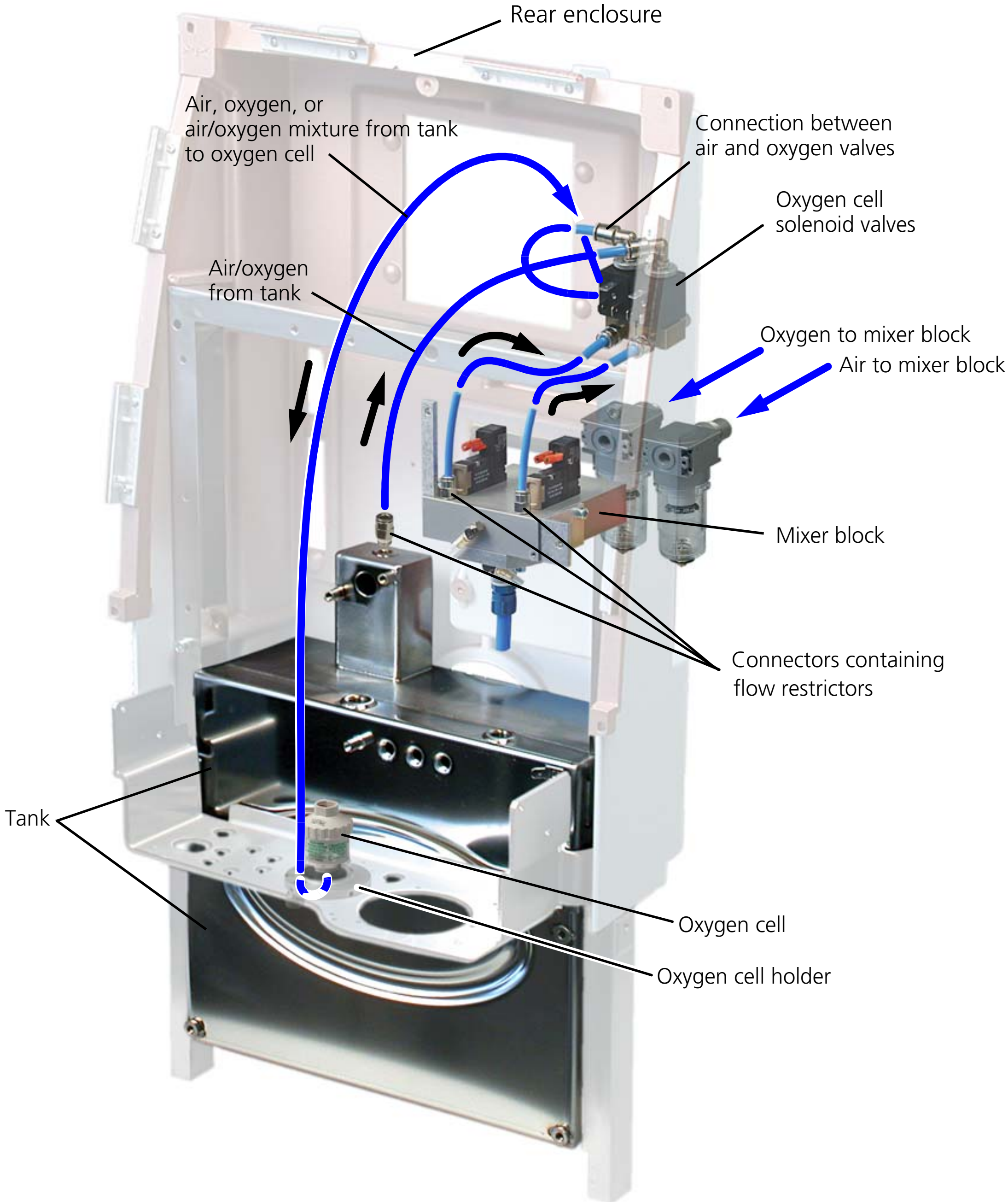


Figure 2-5. Components monitoring oxygen concentration

2.6.1 Introduction

GALILEO can use the oxygen cell to monitor the partial pressure of oxygen in the air/oxygen mixture it delivers to a patient. However, GALILEO does not use the oxygen cell to determine the air/oxygen ratio. This is determined only by the *mixer valves* that deliver gases to the tank (see Section 2.2, *Components managing the principle gas flow*).

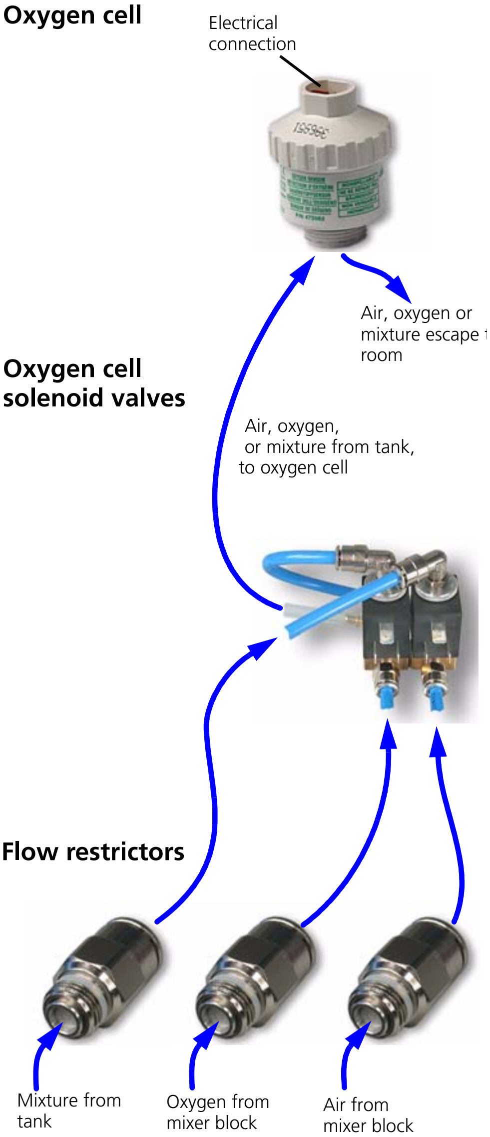
The oxygen cell therefore performs only a backup function, and can be disabled by the user, if required.

WARNING

GALILEO must never be used for ventilating a patient without some means of monitoring the oxygen content in the gas mixture delivered to the patient.

2.6.2 Components monitoring oxygen concentration

Oxygen cell



- The oxygen cell measures the concentration of the oxygen in the oxygen/air mixture in the tank, and therefore the concentration of oxygen that GALILEO delivers to the patient.
- It is fully explained in Section 11.27, *Oxygen cell and cell holder*, on page 11-161.

Oxygen cell solenoid valves

- The oxygen cell solenoid valves switch the flow of air from the air inlet, oxygen from the oxygen inlet, and the air/oxygen mixture from the tank, to the oxygen cell. (In other words, the two valves switch gas from three sources.)
- The flow of the mixture from the tank to the oxygen cell enables GALILEO to measure the concentration of oxygen delivered to the patient.
- The flow of air and oxygen enable GALILEO to calibrate the oxygen cell.
- The valves are fully explained in Section 11.28, *Oxygen cell solenoid valves*, on page 11-168.

Flow restrictors

- Each restrictor is a positioned in a connector.
- The restrictors supply small flows of air from the air inlet, oxygen from the oxygen inlet, and the gas mixture from the tank, to the oxygen cell.
- One connector is screwed into the tank, and two connectors are screwed into the mixer block. (The mixer block acts only as a pathway from the air and oxygen inlets. Mixing takes place in the tank.)
- The restrictors are fully explained in Section 11.32, *Tank and flow restrictors*, on page 11-198.

2.7 Components managing the nebulizer gas flow

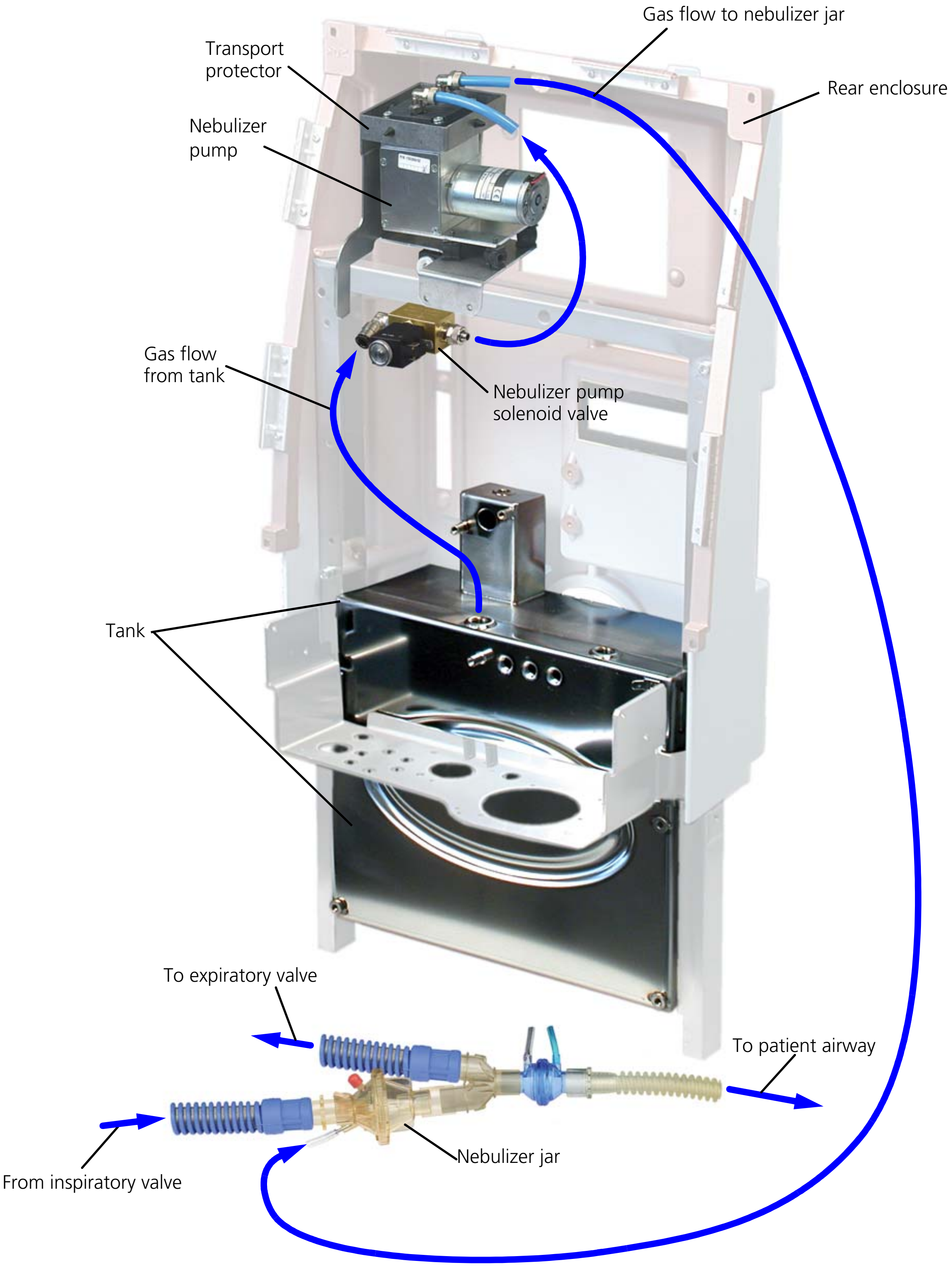


Figure 2-6. Components managing the nebulizer gas flow

2.7.1 Introduction

Some treatment regimes require that a nebulizer jar is placed in the patient circuit to dispense medicine in aerosol form in the air/oxygen mixture that the patient inhales.

When fitted with a suitable nebulizer pump, GALILEO can support the use of such a nebulizer jar by providing a source of air and oxygen, in the same mixture as delivered to the patient in the main patient circuit, but at a pressure sufficiently high to drive a nebulizer.

GALILEO takes the gas that it supplies to a nebulizer directly from the mixture in the tank. This method has the advantage of not disrupting the air/oxygen ratio of the gas that GALILEO delivers to the patient. Furthermore, during nebulization GALILEO automatically reduces the flow of gas through the inspiratory valve, thereby compensating for the additional flow of gas delivered to the patient by the nebulizer.

Note
The nebulizer pump is an option with GALILEO. It is not always fitted.

2.7.2 Components managing the nebulizer gas flow

Nebulizer pump

- The nebulizer pump provides a flow of gas at sufficient pressure (900 mbar, approximately) to drive the nebulizer.
- It is fully explained in Section 11.26, *Nebulizer compressor and solenoid valve*, on page 11-150.

Nebulizer pump solenoid valve

- The nebulizer pump solenoid valve switches on and off the flow of gas from the tank to the nebulizer pump.
- The operator can configure the synchronization of nebulization with inspiration and exhalation. (See the appropriate operators' manual.)
- It is fully explained in Section 11.26, *Nebulizer compressor and solenoid valve*, on page 11-150.

Tank

- The tank is a part of the chassis.
- It provides an oxygen/air mixture to the nebulizer pump, in the same ratio as it supplies to the *inspiratory (servo) valve* during normal ventilation.
- The tank is fully explained in Section 11.32, *Tank and flow restrictors*, on page 11-198.

2.8 Components supporting auxiliary pressure measurement

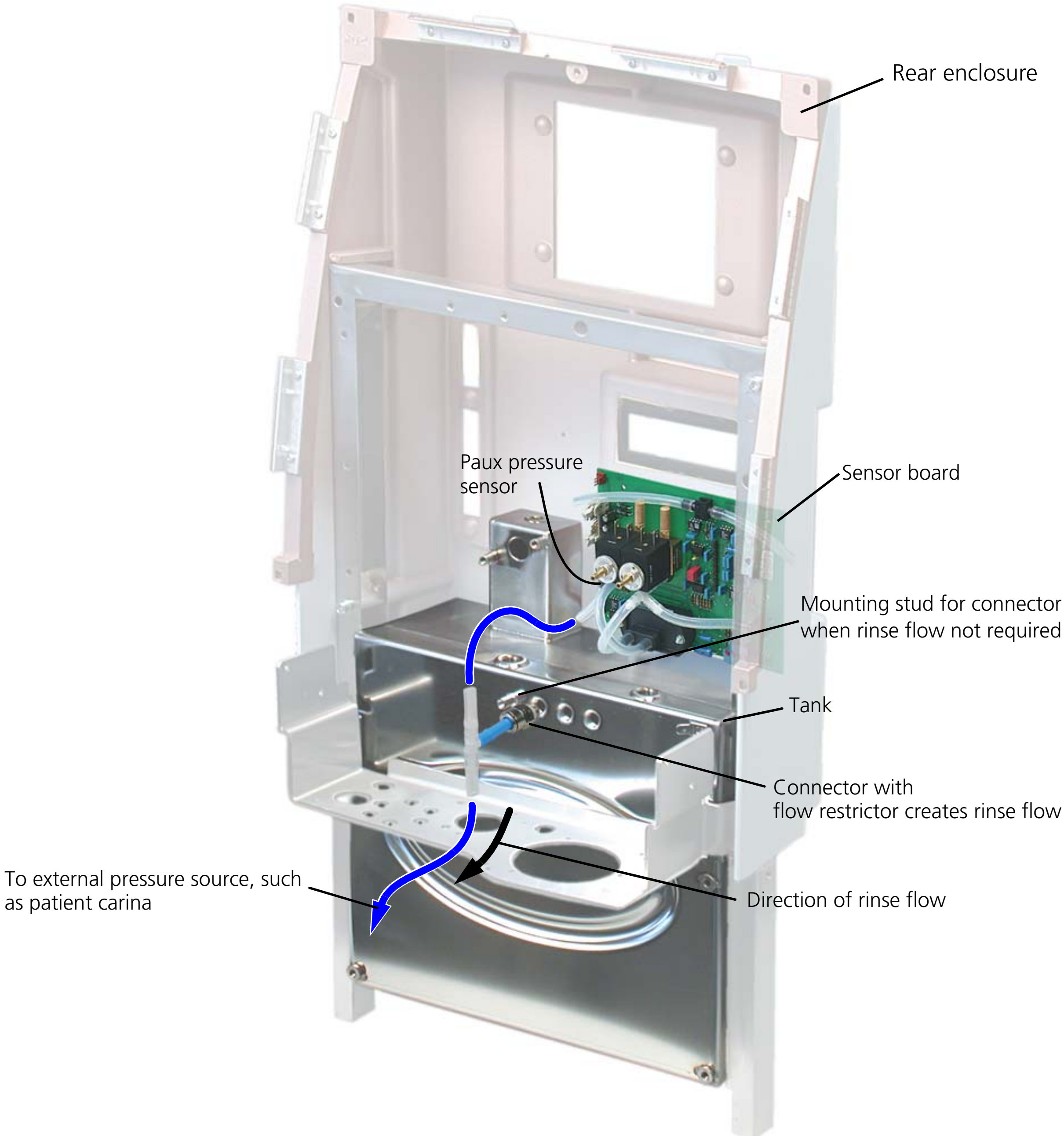


Figure 2-7. Components supporting auxiliary pressure measurement

2.8.1 Introduction

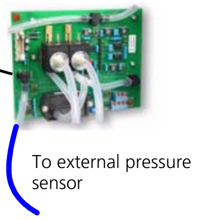
GALILEO can supply the facility for a user to measure pressure at a point and in a manner chosen by the user. Typically, this is in the patient carina or esophagus. This facility is known as auxiliary pressure measurement.

WARNING

The Paux connector is normally supplied with a *rinse flow*. You must cancel this for esophageal pressure measurement. For more information about cancelling the rinse flow, see Section 11.32.6, *Managing tank connections and "pill" flow restrictors*.

2.8.2 Component measuring auxiliary pressure

Paux pressure sensor



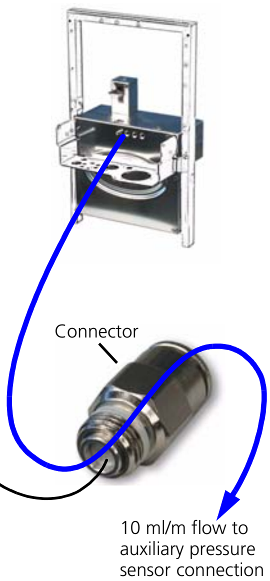
- The Paux pressure sensor is positioned on the *sensor board*.
- It measures the pressure at a point and for a purpose chosen by the operator. (The operator can attach any suitable equipment to the connector on GALILEO's front panel.)

2.8.3 Components generating auxiliary-pressure rinse-flow

Tank

- The tank is a part of the chassis.
- It contains the air/oxygen mixture that GALILEO supplies to the patient during normal ventilation.
- The mixture is above ambient pressure, and so makes a useful source for the *rinse flow*.

Flow restrictor



- The flow restrictor is positioned in a connector screwed into the tank.
- It allows a small flow of gas (10 ml/m, approximately) from the tank to the auxiliary pressure sensor.
- This *rinse flow*, as it is called, minimizes the possibility of tube blockage, and hinders the potential migration of bacteria and viruses from the patient, through the tubes, towards the Paux pressure sensor.
- The tank and flow restrictor are fully explained in Section 11.32, *Tank and flow restrictors*, on page 11-198.

This page left intentionally empty.

Section

3 Electronics: component functions

3.1 Overview

This section introduces you to all the major electronic components in GALILEO that were not included in Section 2, *Pneumatics: components and theory of operation*. Where you require more information, cross-references direct you to other parts of the manual.

This section does not include a theory of operation, because engineers do not require a detailed knowledge of board-level electronics to service and maintain GALILEO. All electronic failures are dealt with by replacing components: board-level repairs (and any repairs at a lower level than the parts provided in Appendix H, *Spare parts*) must not be performed in the field.

Note

The figures in this section show exploded views of GALILEO. Of necessity, components are not always shown in their correct positions in the enclosure, nor in their precisely correct positions relative to one another.

3.2 Components in the front enclosure

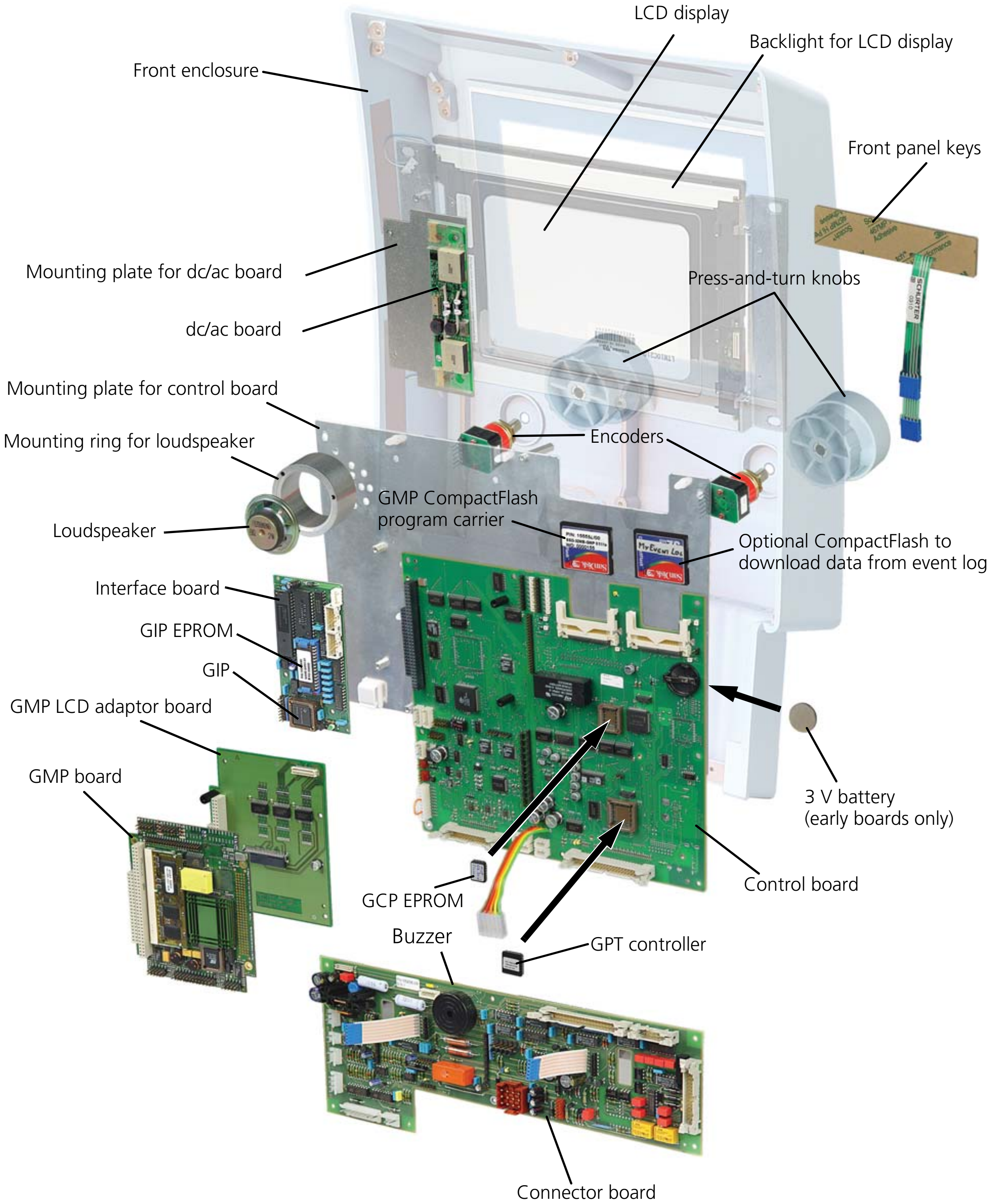


Figure 3-1. Components in the front enclosure

3.2.1 Introduction

Almost all of GALILEO's printed circuit boards are located in the front enclosure. The only exceptions are the *sensor board* and the *servo board* which are in the rear enclosure, as shown Figure 2-2 on page 2-6.

3.2.2 Components in the front enclosure

LCD display and backlights

- The LCD displays numerics and waveforms from the patient, together with the tests included in GALILEO's *test mode*.
- The two backlights light up the display at all times.
- The LCD is fully explained in Section 11.24, *LCD display and backlights*, on page 11-125.

Press-and-turn knobs and encoders

- The P&T-knobs and encoder enable both medical users and engineers to interact with GALILEO.
- The P&T-knobs are mounted on the front of the enclosure. The encoders are mounted inside the enclosure.
- For more information about use during ventilation, see the appropriate GALILEO operators' manual.
- The P&T-knobs and encoder are fully explained in Section 11.30, *Press-and-turn knobs (P&T-knobs) and encoders*, on page 11-184.

Control board

- The *control board* manages inputs and outputs from most parts of GALILEO including the user interface. It holds the integrated circuits containing most of the control logic.
- The control board is fully explained in Section 11.11, *Control board and GMP assembly*, on page 11-45.

dc/ac board

- The *dc/ac board* converts the 12 V dc power supply to 1700 V ac to light up the two backlights for the LCD display.
- The dc/ac board is fully explained in Section 11.12, *dc/ac board*, on page 11-61.

Loudspeaker

- The loudspeaker sounds to indicate *patient alarm*s and *technical faults* alarms.
- For information about alarms, see Section 12.2, *Troubleshooting using technical faults*, and the appropriate GALILEO operator's manual.

Interface board

- The *interface board* functions with the communication interface connector shown on page 3-9, to provide an RS232 interface to send patient data, modes, settings, and alarms to a patient monitor or computer. Also provides a special interface for sending inspiratory:expiratory timing signals and alarms. Holds the GIP (GALILEO Interface Processor) EPROM and the processor itself.
- The communication interface (comprising board and connector) is an option.
- The interface board is fully explained in Section 11.23, *Interface board and GIP EPROM*, on page 11-118.

GMP board

- The *GMP* (GALILEO main processor) is a single board computer that controls both the user interface and high-level aspects of ventilation, such as tidal volume, minute volume and rate.
- In original and Upgrade 1 GALILEOs, the CompactFlash memory (containing the GMP software) and the GMP processor were part of the same assembly. In Upgrade 2 GALILEOs (SN 4000 and higher), the CompactFlash card is mounted on the *control board* as shown in Figure 3-1 on page 3-2.
- The GMP board is fully explained in Section 11.11, *Control board and GMP assembly*, on page 11-45.

GMP LCD adaptor board

- The *GMP adaptor board* controls the LCD display.
- The GMP LCD adaptor board is fully explained in Section 11.11, *Control board and GMP assembly*, on page 11-45.

GMP CompactFlash program carrier

- This is the CompactFlash that carries the software for the GALILEO main processor (*GMP*).
- This item is fully explained in Section 11.19, *GMP CompactFlash program carrier*, on page 11-100.

CompactFlash event-log data-carrier

- This CompactFlash is an option that can be added by the user, to hold the downloaded event log. Downloading of the event log is only available on Upgrade 2 or later GALILEOs.
- For information about downloading the event log, see Test 17, *Event log check & export*, on page 10-94.

GCP PROM

- The *GCP PROM* (GALILEO control processor) PROM contains software for the GCP microprocessor mounted on the control board.
- The GCP PROM is fully explained in Section 11.18, *GCP EPROM*, on page 11-97.

GPT

- The *GPT* (GALILEO Press-&-Turn) controller manages the control and the monitoring press-&-turn knobs, and the four keys on the front panel.
- It contains its own RAM and ROM.
- The GPT is fully explained in Section 11.20, *GPT controller*, on page 11-102.

3 V battery

- A 3 V battery was fitted to all GALILEOs before Upgrade 2 models with control board PN 155461 Rev 04.
- It provides power for the real-time clock.
- The 3 V battery is fully explained in Section 11.8, *Battery, 3 V*, on page 11-27.

Connector board

- The *connector board* manages:
  - Other circuit boards
  - Valves
  - Keys on the front of the GALILEO
  - Power supply
  - P&T-knobs
- The connector board is fully explained in Section 11.10, *Connector board*, on page 11-39.

Buzzer

- The *buzzer* buzzer is a piezoelectric device used by GALILEO to sound some alarms.
- It functions independently of the loudspeaker and the main power supply, and typically indicates a technical fault that causes GALILEO to go into the *ambient state*.
- It is mounted on the connector board and cannot be replaced, apart from replacing the connector board.
- For information about alarms, see Section 12.2, *Troubleshooting using technical faults*, on page 12-2, and the appropriate GALILEO operator's manual.

Front panel keys

- The front panel keys enable both medical users and engineers to interact with GALILEO.
- The keypad is stuck to GALILEO's front panel, and connects directly to the connector board.
- For more information about use during ventilation, see the appropriate GALILEO operators' manual.
- The front panel keys are fully explained in Section 11.16, *Front panel keys*, on page 11-84.

This page intentionally left empty.

3.3 Components in the rear enclosure

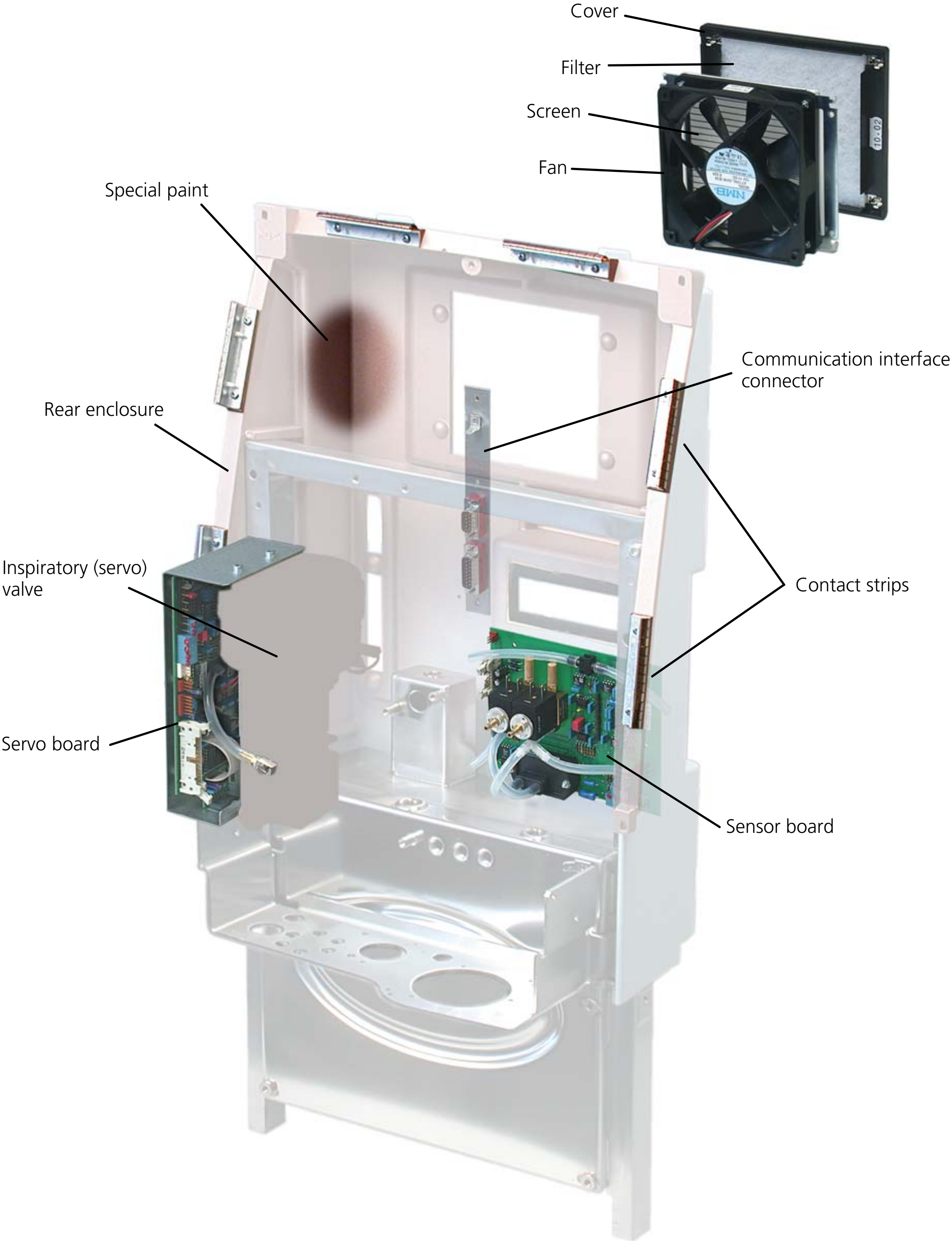


Figure 3-2. Miscellaneous components and features in the rear enclosure

3.3.1 Introduction

The following section lists the two printed circuit boards and the several miscellaneous components that are housed in the rear enclosure.

3.3.2 Components in the rear enclosure

Communication interface connector

- This connector provides an RS232 interface to send patient data, modes, settings, and alarms to an external patient monitor or computer.
- It also provides a special interface connector for sending inspiratory:expiratory timing signals and alarms.
- The interface is an option, and can only be fitted together with the *interface board* as shown in Figure 3-1, *Components in the front enclosure*, on page 3-2.
- The communication interface is fully explained in Section 11.23, *Interface board and GIP EPROM*, on page 11-118, and in Appendix B, *Communication interface specifications*.

Fan and filter

- The fan prevents oxygen accumulating inside GALILEO (thereby avoiding any possible risk of explosion).
- It also provides cooling to the electrical circuits.
- The fan assembly also includes a screen and cover, which support the filter.
- The filter prevents dust entering GALILEO with the air drawn in by the fan.
- The fan is fully explained in Section 11.14, *Fan*, on page 11-71.
- For information about replacing the filter, see Section 5, *Hospital preventive maintenance*.

Special paint

- Special conductive paint prevents interference between GALILEO and devices producing radio waves (for example, mobile phones). The paint is used in both front and rear enclosures.

Contact strips

- Contacts strips of two sizes ensure good electrical connection between front and rear enclosures.
- In later models, there are also contact strips between the control board and the enclosure.
- The part numbers are PN 369074 and PN 369082, shown in Appendix H.19, *Miscellaneous* on page H-25.

Servo board

- The *servo board* holds the:
  - *dP servo differential pressure sensor*
  - *Ppat pressure sensor*
- These sensors are discussed in Section 2.3, *Components performing principle pressure and flow measurements*, on page 2-6.
- In addition, the servo board holds the potentiometers that enable engineers to calibrate these pressure sensors.
- The fan plugs into the servo board in original and Upgrade 1 GALILEOs.
- The servo board is fully explained in Section 11.22, *Inspiratory (servo) valve and servo board*, on page 11-108.

Sensor board

- The *sensor board* holds the:
  - *dP mixer differential pressure sensor*
  - *dP Flow Sensor differential pressure sensor*
  - *Paw pressure sensor*
  - *Paux pressure sensor*
  - *Flow Sensor autozero valves*
- These items are discussed in Section 2.3, *Components performing principle pressure and flow measurements*, on page 2-6.
- In addition, this board also holds the potentiometers used by engineers to calibrate these pressure sensors. Further components include amplifiers and filters.
- For general and replacement information, Section 11.31, *Sensor board*, on page 11-192.

This page intentionally left empty.

3.4 Components in the column

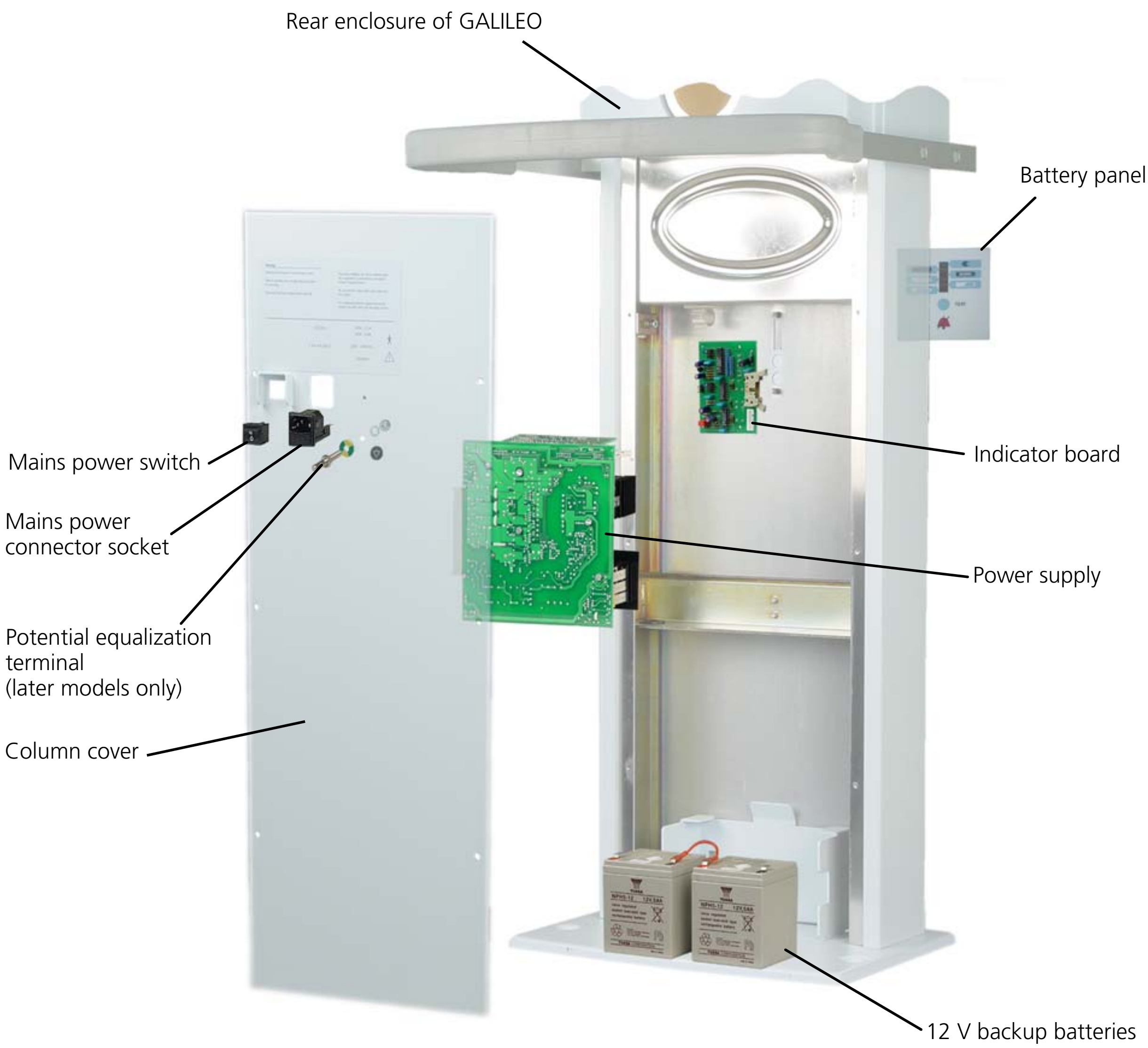


Figure 3-3. Components in the column

3.4.1 Introduction

The components in the column are all concerned with the power supply.

All GALILEOs produced today have backup batteries and power supply PN 155352. However, some older models do not have backup batteries, and have power supply PN 396136.

3.4.2 Components in the column

Mains power connector socket

- The mains socket enables mains power in the range 100 to 240 V ac, 50 to 60 Hz to be supplied to GALILEO.
- The part number is PN 340345, shown in Appendix H.19, *Miscellaneous* on page H-25.

On/off switch

- Switches GALILEO on and off. If switched on, but mains power is not connected, GALILEO starts using battery power.
- Associated part numbers are PN 376007 (old type), and PN 376010, shown in Appendix H.19, *Miscellaneous* on page H-26.

WARNING

The on/off switch does not isolate GALILEO from the mains power supply. If the mains cable is connected, mains voltages are always present in the power supply, even when GALILO is switched off.

Power supply

- The *power supply* supplies power at +5 V, +12 V, +15 V and -15 V to GALILEO's valves and printed circuit boards.
- The power supply is fully explained in Section 11.29, *Power supply and fuses*, on page 11-176.

12 V Backup batteries

- The backup batteries enable GALILEO to ventilate a patient for at least 20 minutes in the absence of mains power.
- The batteries charge continuously when GALILEO is connected to the mains supply, whether or not GALILEO is switched on.
- The backup batteries are fully explained in Section 11.9, *Batteries, 12 V*, on page 11-32.

Indicator board

- The *indicator board* provides the switches and LEDs that lie under the battery panel.
- The indicator board is fully explained in Section 11.21, *Indicator board / battery panel*, on page 11-104.

Battery panel

- This is a sticker that covers the switches and LEDs of the *indicator board*.
- The battery panel is fully explained in Section 11.21, *Indicator board / battery panel*, on page 11-104.

Potential equalization terminal

- The potential equalization terminal enables GALILEO to be linked by a common ground (earth) to other pieces of equipment. This ensures that there is no potential difference between equipment.
- The part number is PN 340272, shown in Appendix H.19, *Miscellaneous* on page H-25.

Part 2: Preventive maintenance and testing

Section

4 Overview of preventive maintenance and testing

WARNING

- **To prevent disease transmission, you must use personal protective equipment when handling contaminated bacterial filters or other patient accessories. Refer to one of the operator's manuals for instructions on sterilizing patient system parts.**
- **You must complete a service training course for GALILEO ventilators with HAMILTON MEDICAL before undertaking the maintenance and testing procedures described in this manual.**
- **You must perform all preventive maintenance and testing after you have replaced any component, and also once a year or every 5000 operating hours, whichever comes first. To perform preventive maintenance, you perform all the steps shown in Table 4-2.**

CAUTION

Make sure to take full ESD (electrostatic discharge) precautions before handling any EPROM, or before opening GALILEO. For more information, see Appendix A, *Maintenance tools and test equipment*.

4.1 Introduction

You must perform all preventive maintenance and testing in the following circumstances:

- After you have replaced any component.
- Once a year or once every 5000 operating hours, whichever comes first.

To perform preventive maintenance, you perform all the steps shown in Table 4-2.

4.2 Checking your software level

In general, HAMILTON MEDICAL AG recommends that you always update to the latest software available. Software is shown on the HAMILTON MEDICAL AG Partner Web Site (http://www.hamilton-medical.com/partner-site) under the menu heading *Updates & Upgrades*.

4.3 Checking you have all the items you require

Step	Items required, or possibly required
• Section 5, *Hospital preventive maintenance* • Section 6, *Engineer preventive maintenance*	• *GALILEO Operator's Manual* PN 610862/01 or local-language equivalent (you can find this on the HAMILTON MEDICAL AG Partner Website (http://www.hamilton-medical.ch/partner-site) • Fan filter PN 279166 • Flow Sensor. Any of the following: • PN 155362, pediatric/adult, reusable • PN 155500, infant, single-patient use • PN 279331, pediatric/adult, single-patient use • Gas inlet microfilter elements: • For old-model mixer block PN 155333: microfilter element PN 279676 • For new-model mixer block PN 155587: microfilter element PN 155714 • Gas inlet water trap bowl for new mixer block PN 155587 • Oxygen cell. Either of the following types: • PN 396008 from Catalyst • PN 396009 from Teledyne • 12 V backup batteries set PN 369089 • 3 V "button" battery PN 369069 • Nebulizer maintenance kit PN 399097 • LCD display backlight PN 380022 **Note** Details of parts are shown in Appendix H, *Spare parts*.
• Section 7, *Checking hardware, voltages, and interface* • Section 8, *Checking electrical safety* • Section 9, *Running Original or Upgrade 1 test software* • Section 10, *Running Upgrade 2 test software*	• Tools. **Note** Details of tools are shown in Appendix A, *Maintenance tools and test equipment*.

Table 4-1. **Items required for preventive maintenance and testing**

4.4 Procedure

Work methodically through the sections shown in Table 4-2.

WARNING

Maintenance and testing is not complete until all steps are successfully performed.

	Step	Task	Where found	Time Required
	1	Perform (or assure yourself that someone else has performed) the preventive maintenance normally undertaken by hospital staff.	Section 5, *Hospital preventive maintenance*.	5–15 min
	2	Perform the engineer preventive maintenance.	Section 6, *Engineer preventive maintenance*.	10 min
Repeat until all tests run correctly	3	Perform these tests to prepare GALILEO for the test software tests.	Section 7, *Checking hardware, voltages, and interface*.	15 min
	4	Perform the electrical safety tests.	Section 8, *Checking electrical safety*.	10 min
	5	Perform the tests and calibrations made available to you by running the test software built into GALILEO.	One of the following: • Section 9, *Running Original or Upgrade 1 test software* • Section 10, *Running Upgrade 2 test software*	90 min
	6	Perform any replacements necessary[a]	Section 11, *Component details and replacement procedures*.	Depends on work required
	7	Lock all the potentiometer adjustment screws in place using proprietary locking paint or nail varnish.	No special description included in manual.	2 min
	8	Close the enclosure, and screw it together.	No special description included in manual.	2 min
	9	Finish the testing of the unit by completing the tasks documented in the *Tests and calibrations* section of the *GALILEO Operator's Manual*.	*GALILEO Operator's Manual* PN 610862/01 or local-language equivalent. (You can find this on the HAMILTON MEDICAL AG Partner Website (http://www.hamilton-medical.ch/partner-site).	10 min

Table 4-2. **Maintenance and testing procedure overview**

a. If you make a replacement, you must go back to step (3).

Section
5 Hospital preventive maintenance

5.1 Hospital preventive maintenance

Table 5-1 shows the maintenance tasks that hospital staff must perform. It is copied from the English version of the GALILEO operator's manual.

Examine each GALILEO for which you are responsible, and satisfy yourself that hospital staff are regularly performing these tasks. If necessary:

- Perform the tasks yourself.
- Train staff how to perform these tasks.

Interval	Part/accessory	Procedure
Between patients and according to hospital policy.	Breathing circuit (including mask, inspiratory filter, Flow Sensor, nebulizer jar, exhalation valve cover, and membrane).	Replace with sterilized or new single-patient use parts. Run the tightness test and the Flow Sensor calibration as shown in the GALILEO operator's manual.
	Entire ventilator.	Run the preoperational check as shown in the GALILEO operator's manual.
Every day or as required.	Gas inlet water trap.	Empty any water by pressing on drain valve.
Every 2 days or according to hospital policy.	Breathing circuit.	Empty any water from breathing tubes or water traps. Inspect parts for damage. Replace as necessary.
Every month (or more often, if required).	Fan filter. **WARNING** **To reduce the risk of patient cross-contamination through the fan filter, always perform maintenance at the prescribed level.**	Check for dust and lint. If needed, clean or replace as shown in the GALILEO operator's manual.

Table 5-1. Hospital preventive maintenance schedule

Section

6 Engineer preventive maintenance

WARNING

This section is not a stand-alone, independent part of the manual. Perform the tasks detailed here only as a part of, and as instructed by, Section 4, *Overview of preventive maintenance and testing*.

6.1 Engineer preventive maintenance

Perform the engineer maintenance, according to the table below:

Interval	Part/accessory	Procedure
Every year or every 5000 operating hours, whichever comes first.	Gas inlet water trap bowl on new mixer block PN 155587 (Figure 6-1 on page 6-2).	If older than 10 years, or if damaged by cracking, crazing or hazing, replace with PN 155713.
	Gas inlet microfilter.	Make sure that the gas inlet microfilter elements are clean. If they are discolored, replace them. (See Figure 11-101, *Details of gas inlet assembly PN 279677*, on page 11-93.) For old mixer block PN 155191 (Figure 6-1 on page 6-2) use microfilter PN 279676. For new mixer block PN 155587 (Figure 6-1 on page 6-2) use microfilter PN 155714.
Every two years, or every 5000 hours of battery use, or as necessary.	12 V backup batteries.	If fitted, replace as described in Section 11.9.5, *Replacing the 12 V backup batteries*, on page 11-37. (If you are not sure of the age of the batteries, see Section 11.9.4.5, *Determining the age of your batteries*, on page 11-34.) Recycle the batteries, or return them to HAMILTON MEDICAL AG.
Every 5,000 operating hours.	Nebulizer compressor membrane.	Replace as described in Section 11.26.6, *Maintaining or replacing the nebulizer compressor and solenoid valve*, on page 11-153.
Every 20,000 operating hours.	LCD display backlight.	Replace as described in Section 11.24.6, *Replacing the LCD display and backlights*, on page 11-127.

Table 6-1. Engineer preventive maintenance

Figure 6-1. Water traps on old mixer block PN 155191

Figure 6-2. Water traps on new mixer block PN 155587

Section 7 Checking hardware, voltages, and interface

WARNING

This section is not a stand-alone, independent part of the manual. Perform the tasks detailed here only as a part of, and as instructed by, Section 4, *Overview of preventive maintenance and testing*.

CAUTION

You must take the full ESD (electrostatic discharge) precautions shown in Appendix A.3.5, *ESD protection*, on page A-3, before opening GALILEO.

7.1 Opening GALILEO

1. Take the full ESD (electrostatic discharge) precautions shown in Appendix A.3.5, *ESD protection*, on page A-3.
2. Remove from GALILEO:
   - External mains power supply
   - Air and oxygen supplies
   - Patient breathing circuit (for convenience only)
   - Flow Sensor tubes (for convenience only)
3. Remove the four hexagonal-drive (Allen) screws at the rear of the enclosure. Figure 7-1 shows where two screws were removed from the right side of the enclosure.

Figure 7-1. **Positions of the screws securing the main enclosure**

4. Tip the front of the enclosure forward to expose the interior.

7.2 Checking general hardware

1. Make sure that all cables and tubes in the GALILEO are in good condition. In particular, pipes must not be kinked because of being incorrectly routed, and must be fully pressed home on their connectors.
2. Make sure all assemblies are correctly installed and are undamaged. This includes additional equipment such as the nebulizer compressor.
3. If the GALILEO has control board PN 155461 Rev 04 or later, make sure that the microswitches are correctly set. For more information, see *Microswitch settings for GMP assemblies* on page 11-51.
4. If the GALILEO does not have battery backup, make sure that the connector board is PN 155256 Rev 05 or higher. (Boards of earlier revisions can be associated with unreliable emergency alarm performance if mains power is switched off.)

   The part number is marked on a white identification label on the board. (Figure 7-2.)

WARNING

If necessary, fit a new board now, as described in Section 11.10.6, *Replacing the connector board*, on page 11-40.

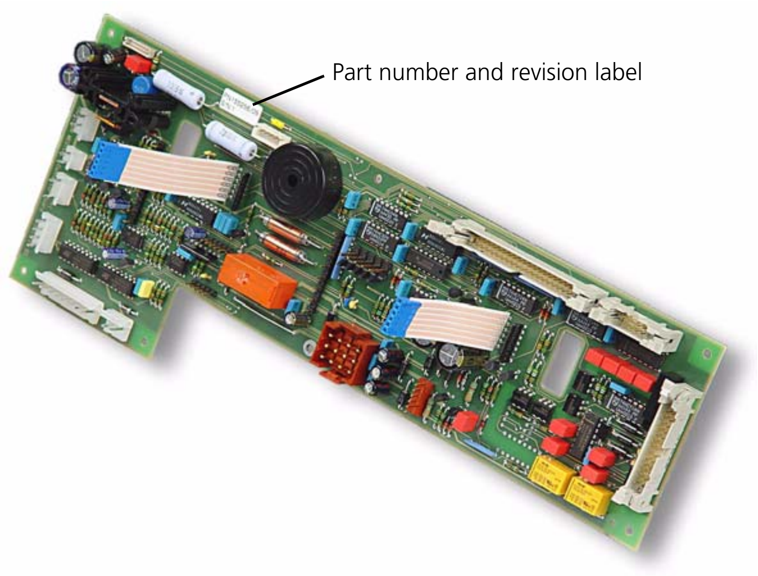


Figure 7-2. Position of identification label on connector board

7.3 Checking voltages

7.3.1 3 V clock battery

1. Locate the 3 V clock battery. The battery is in different positions on different models of *control board*, and is ***not present*** in later versions of control board PN 155461 Rev 04, and also not present in all versions of PN 155461 Rev 05, as shown in Table 7-1, *3 V battery positions*.

   Where present, the battery always looks similar to the battery shown in Figure 7-3.

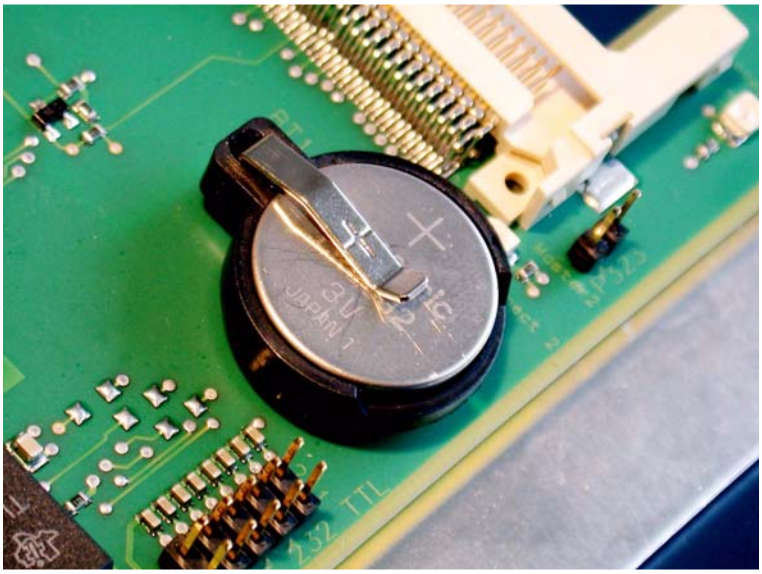
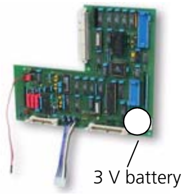
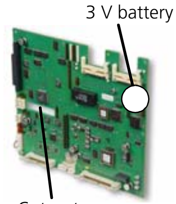
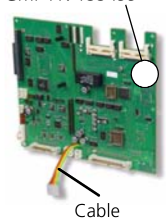
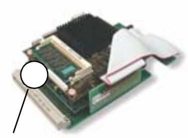
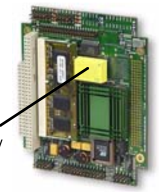


Figure 7-3. The 3V clock battery

2. If the battery is older than 3 years, or if you are not sure of the age of the battery, replace it.

With some types of control board, you can push the battery out of its holder with a thumb. (The battery holder is marked “Push”.) However, with other types, you must ease the battery out by first lifting it with a small screwdriver, and then pushing it out.

<table>
<tr><th></th><th colspan="2">PN 155154</th><th colspan="2">PN 155461</th></tr>
<tr><th></th><th>Original GALILEO</th><th>Upgrade 1 GALILEO
(“silver”)</th><th colspan="2">Upgrade 2 GALILEO (Classic or Gold)</th></tr>
<tr><td>Control board</td><td>PN 155154

</td><td>PN 155154
</td><td>PN 155461
Rev 00 to 03

</td><td>PN 155461
Rev 04 and later

</td></tr>
<tr><td>GMP hardware</td><td>PN 396138
</td><td>PN 155460

</td><td>PN 155499

For control board PN 155461 Rev 00 to 03, and for early versions of control board PN 155461 Rev 04.</td><td>CPU module PN 396170


LCD adaptor PN 155563

For later versions of control board PN 155461 Rev 04, and later.

Note
3 V battery not present with this configuration.</td></tr>
</table>

Table 7-1. 3 V battery positions

7.3.2 Supply-voltage checks on the control board

The following checks measure voltages supplied by the power supply in the column (although you perform the measurements on the control board).

1. Determine the version of the control board:
   - You can do this by looking at the white label stuck to the board, as shown on Figure 7-4.
   - Alternatively, if the label is missing, you can determine the version of the control board by looking at Table 7-1, *3 V battery positions*.

Note
Do not determine the board number from any information etched into the board.

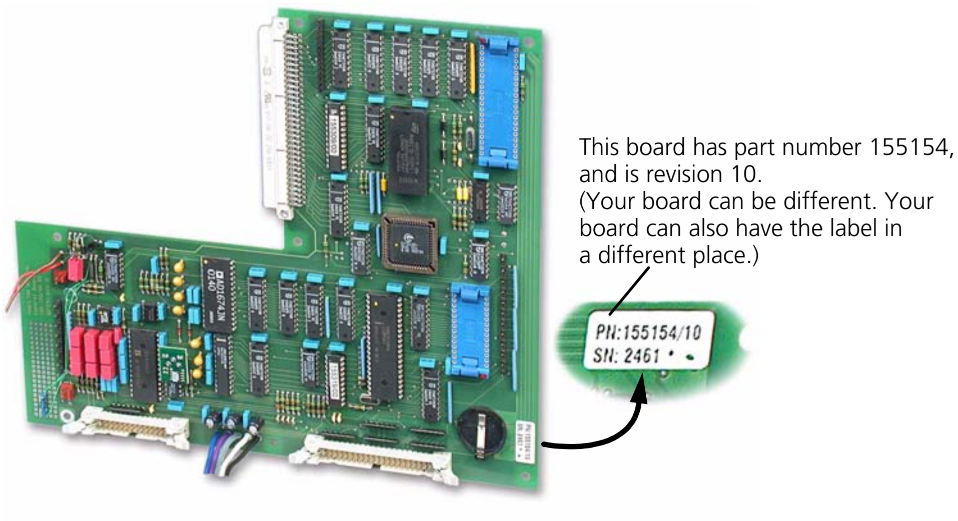


Figure 7-4. Position of label on control board PN 155154

2. Perform ***one*** of the following checks:
   - Section 7.3.2.1, *Voltage check with control board PN 155154*, on page 7-6
   - Section 7.3.2.2, *Voltage check on control board PN 155461*, on page 7-7

7.3.2.1 *Voltage check with control board PN 155154*

1. Locate the test pins 1–12 and 13–20. Neither set is numbered on the board. (Figure 7-5.)
2. Locate the soldered connections on the cable to the connector board. These are shown in detail below the main photograph in Figure 7-5.
3. Check the voltages between the pairs of pins, as shown in Table 7-2.

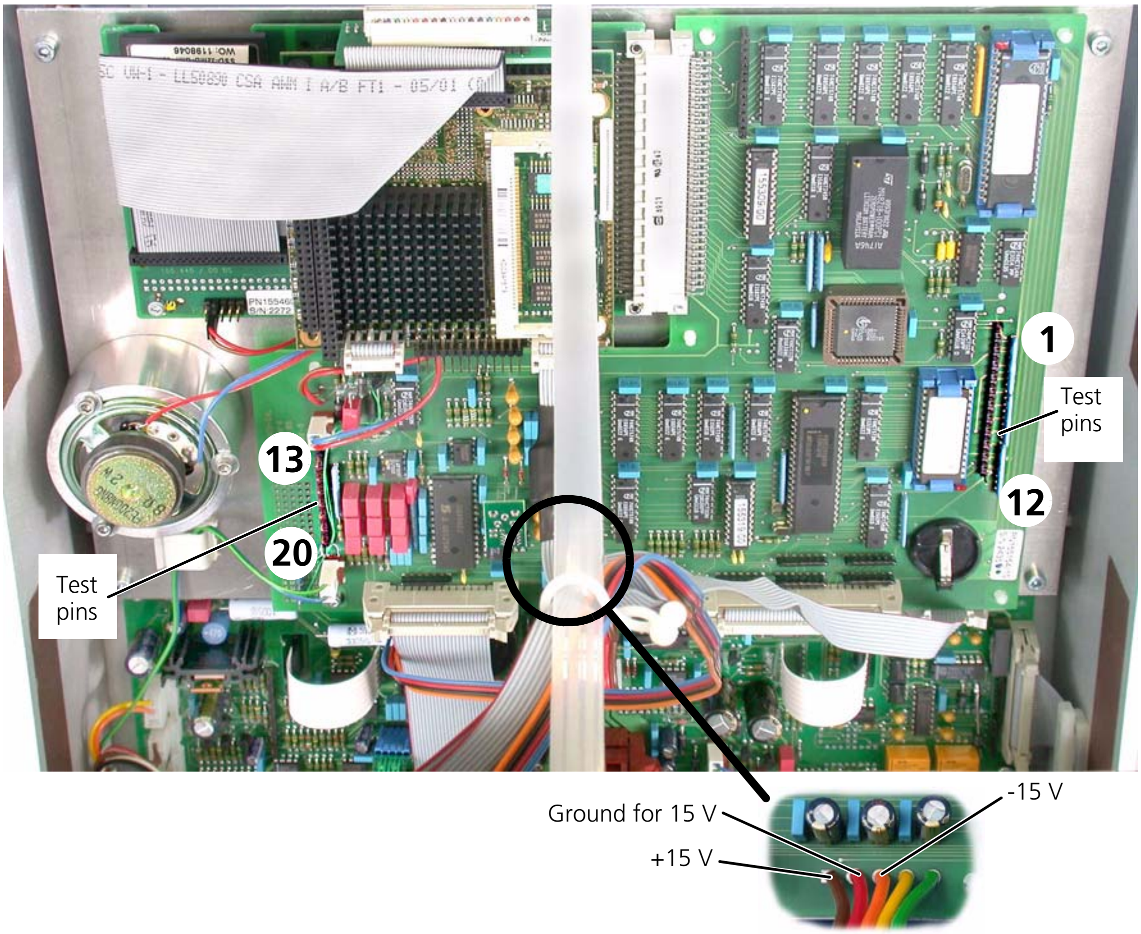


Figure 7-5. **Test pins on control board PN 155154/xx**

	Measurement points	Voltage range
Test pins	1 (ground) and 6	+4.85 V to +5.25 V
	13 (ground) and 16	+9.74 V to +10.74 V
Soldered connections on cable to connector board	Ground and +15 V	+14.3 V to +15.7 V
	Ground and -15 V	-14.3 V to -15.7 V

Table 7-2. **Pin voltages on control board 155154/xx**

7.3.2.2 *Voltage check on control board PN 155461*

1. Locate the test pins 1–12 and 13–20 on the control board. (Figure 7-6.)
2. Check the voltages between the pairs of pins, as shown in Table 7-3.

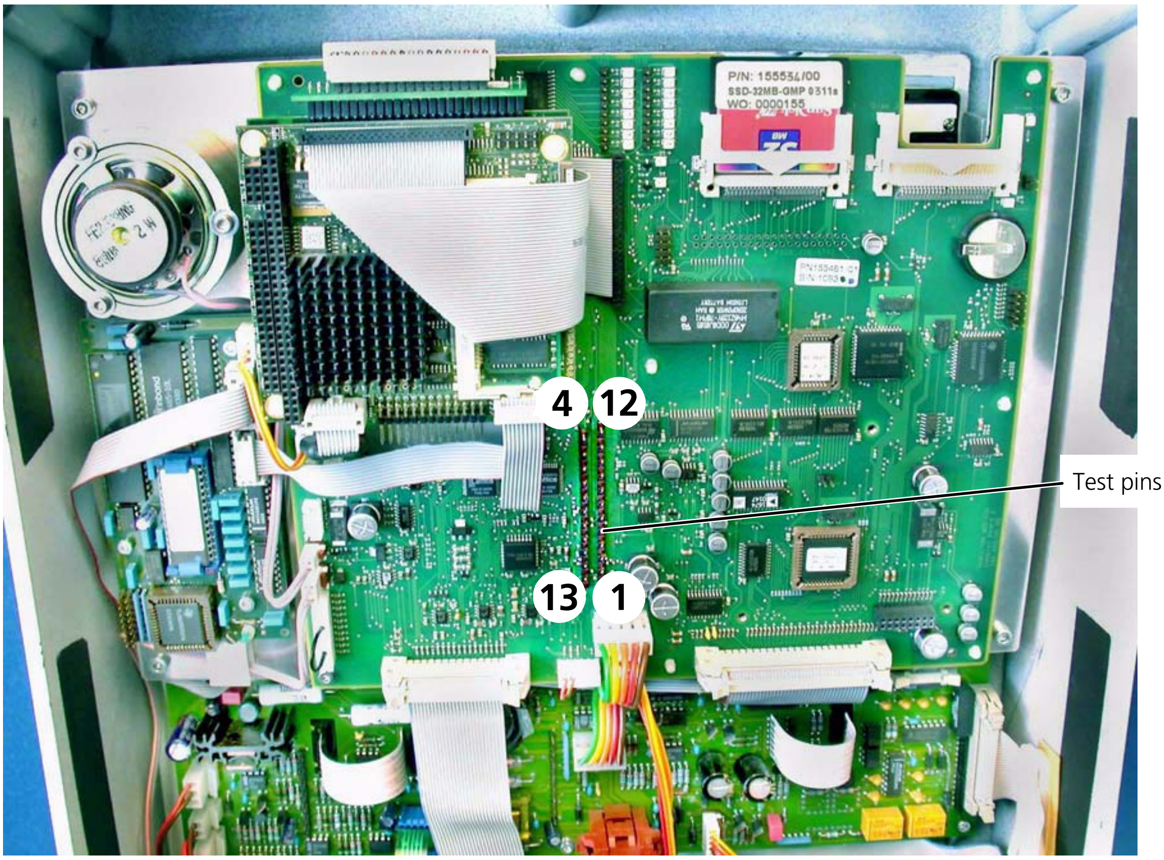


Figure 7-6. **The test pins on control board (PN 155461/xx)**

Pin pairs	Voltage range	Corresponding LED on power supply
1 (ground) and 19	+4.85 V to +5.25 V	LED 1
13 (ground) and 16	+9.74 V to +10.74 V	None
13 (ground) and 20	+14.3 V to +15.7 V	LED 2
13 (ground) and 21	-14.3 V to -15.7 V	LED 3

Table 7-3. **Pin voltages on control board 155461/xx**

7.3.3 Supply-voltage checks on the connector board

The following test is for all kinds of *connector board*.

1. Locate test pins 1–8 at the center of the connector board (Figure 7-7). Pin 1 is at the top, and Pin 8 is at the bottom. The numbers are not marked.

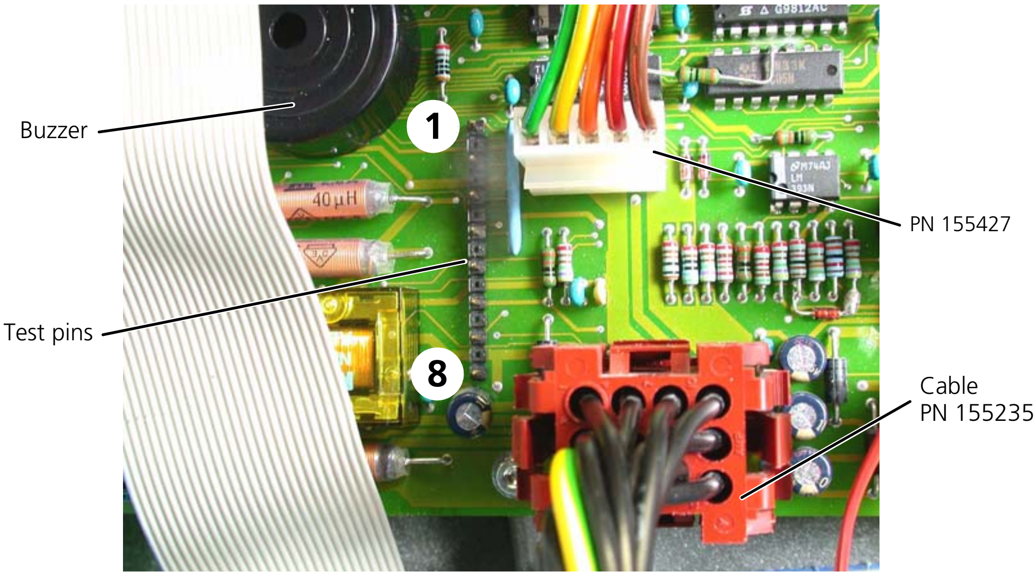


Figure 7-7. The test pins on connector board 155256/xx

2. Check the voltage between the following pair of pins:

Pin pair	Voltage range	Corresponding LED on power supply
1 (ground) and 4	+11.4 V to +12.6 V	LED 4

Table 7-4. Pin voltages on control board PN 155256/xx

7.3.4 Troubleshooting voltage checks

If any voltages were incorrect (apart from the 3 V battery, which you must replace), respond according to the following table:

Symptom	Possible Causes	Action
5 V supply to control board has no value or is too low.	• Poor connection between internal power supply and point at which voltage is measured on control board. • Power supply failure.	• Check the 5 V supply between test pin 1 (ground) and test pin 5 on the connector board (Figure 7-7 on page 7-8). • If the voltage is in range on the connector board, check connection of cable PN 155427 to the control board (Figure 7-7 on page 7-8). • If the voltage is out of range on the connector board, check the power supply as described in Section 12.3.2, *Power supply board LED troubleshooting*, on page 12-62, and replace if faulty. • If the power supply is not faulty, contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).
One or more readings has no value. One or more readings too low.	• Poor connection between internal power supply and point at which voltage is measured. • Power supply failure.	• Check the power supply as described in Section 12.3.2, *Power supply board LED troubleshooting*, on page 12-62, and replace if necessary. • Check all connections between the power supply and the point at which you performed the measurement. • If all connections appear to be in order, replace the power supply. This is described in Section 11.29.8, *Replacing the power supply*, on page 11-179.
One or more readings too high.	Power supply failure.	Replace the power supply. This is described in Section 11.29.8, *Replacing the power supply*, on page 11-179.

Table 7.5: Troubleshooting voltage checks

7.4 Checking the communication interface

Where fitted, you must check the two interfaces included in the communication interface option:

- RS232 interface: Used to communicate information about the patient and about the ventilator settings to peripherals such as a computer or monitor.
- Special interface: Used to activate an external nurse alarm, external ventilator, or external nitric oxide device.

7.4.1 RS232 interface check

The easiest way to perform a check on the RS232 interface is to:

1. Connect an external monitor.
2. Operate the GALILEO normally.
3. Ensure that the monitor displays suitable values.

Note
It does not matter whether the external monitor uses HAMILTON MEDICAL RS232 protocols or Philips' VueLink Open Interface protocols. GALILEO must operate in either case, switching automatically to the appropriate protocol without any user intervention.

If you cannot connect an external monitor, be assured that the internal tests automatically performed by GALILEO at startup provide considerable certainty that the RS232 interface is correctly installed.

7.4.2 Special interface check

7.4.2.1 Overview

It is possible to test the Special interface by connecting one or more of the following, and ensuring that it operates correctly:

- External nurse call device (remote alarm port)
- External nebulizer (I:E relay port)
- External nitric oxide device (I:E relay port)

However, the easiest and recommended way to test the Special interface is with a multimeter. This procedure enables you to test both the external nurse alarm function, and the I:E function.

Before you can test the communication interface, you must first configure the Special port of the interface to send I:E signals suitable for testing.

Note

- With software version 3.41f and later, if you switch off GALILEO while in normal ventilation mode and then switch it on again within one minute, GALILEO resumes normal ventilation. (This behavior is different to earlier software versions, in which the startup screen was always displayed after switching on, and the user always had to initiate ventilation.) The new behavior is for additional safety in the event of combined mains power and backup-battery failure. In such a case, if the GALILEO is quickly powered on, normal ventilation resumes immediately and automatically.
- To access the startup screen at any time, switch on GALILEO while keeping the Monitoring knob pressed.

7.4.2.2 Configuring the Special port for testing

1. Switch on the GALILEO as if you were going into test mode. (This is described in the *GALILEO Service Manual including maintenance, repairs and tests* (PN 610207)).
   The HAMILTON MEDICAL setup screen is displayed. (Figure 7-8 shows the GALILEO Gold version of the setup screen. Your screen must be very similar or identical to this.)

Figure 7-8. The GALILEO Gold setup screen (you might not have the Gold version of GALILEO)

2. Activate the **`Configuration`** button on the setup screen. A **`Configuration`** menu identical or similar to the one shown in Figure 7-9 opens.

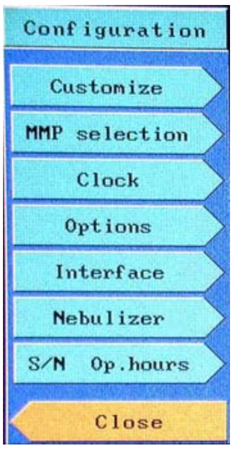


Figure 7-9. A Configuration menu

3. Activate **`Interface`** in the **`Configuration`** menu.

4. Make a note of your communication interface settings in the table below. (You must reset these later.):

Parameter	Relay contact position
Insufflation	
Pause	
Expiration	

Table 7-6. Special interface original configuration

5. In the **`Interface`** window, set all three **`I:E Outlet`** parameters for testing.
   The settings recommended are:

Parameter	Relay contact position
Insufflation	Open
Pause	Closed
Expiration	Open

Table 7-7. Special interface test configuration

6. Activate **`Close`** on the **`Interface`** menu, and then **`Close`** on the **`Configuration`** menu, to return to the HAMILTON MEDICAL setup screen. (Figure 7-8.)
7. Activate **`Start`**. The GALILEO stores your settings, and starts in normal operating mode.
8. Switch off the GALILEO.

7.4.2.3 Checking the Special interface

1. Connect the GALILEO, complete with patient circuit and test lung, to the mains power supply.
2. Switch on the GALILEO, and go into S-CMV ventilation mode, making sure that the **`Pause`** value is 50%.
3. Set the multimeter to measure resistance.

4. Test the I:E relay port:
   a. Connect the multimeter between pin 7 and pin 14 of the Special interface as shown in Figure 7-10.

Note
For background information, see Appendix B.3.3, *Sending a remote nurse alarm*, on page B-8.

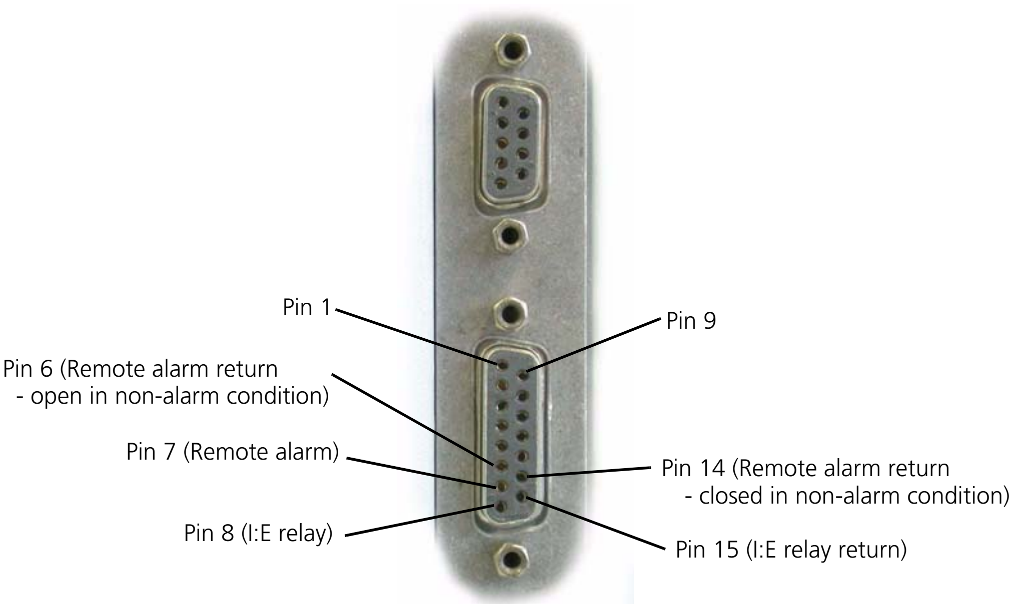


Figure 7-10. Special connector pin locations

   b. Ensure that the response of the multimeter follows the respiration curve. (It is helpful to listen for the opening and closing of the I:E relay while doing this.)

   Figure 7-11 plots a simplified curve against the opening and closing of the relay, when the relay is configured as suggested in Table 7-7, *Special interface test configuration*.

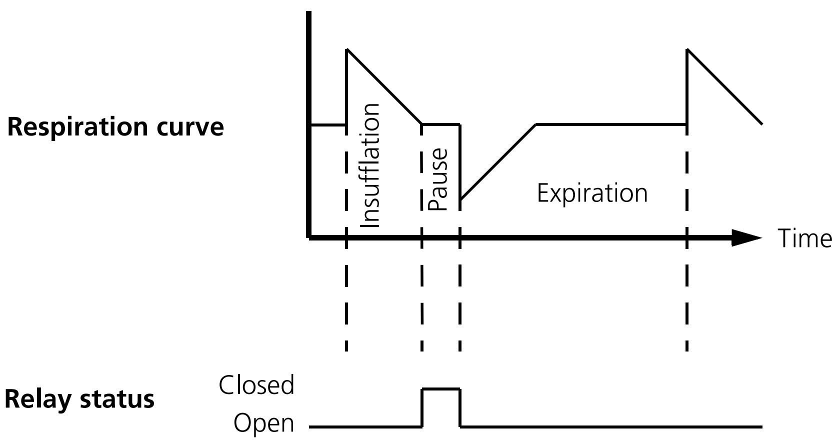


Figure 7-11. The respiratory curve and relay status

5. Test the remote alarm port:
   a. Ensure that there is no patient alarm condition.
   b. Connect the multimeter between pin 7 and pin 6 of the Special interface as shown in Figure 7-10.
   (The relationship of pin 7 and pin 6 to the remote alarm relay is shown in Figure 7-12.)

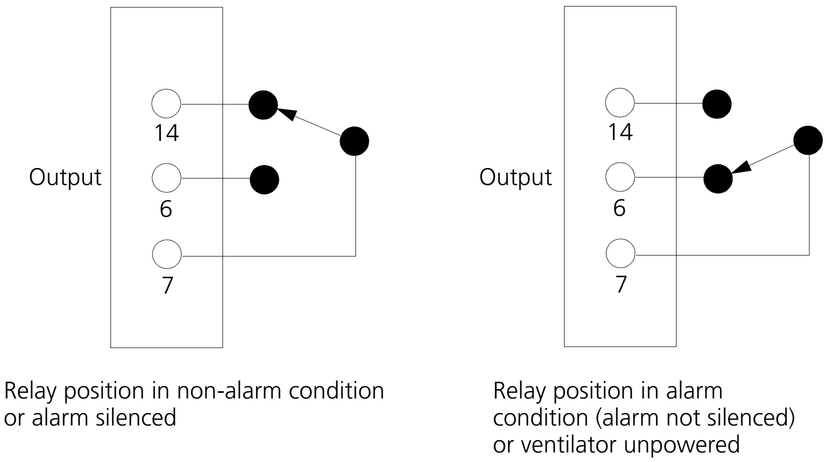


Figure 7-12. Remote alarm relay positions

   c. Using the multimeter, ensure that there is no connection between pin 7 and pin 6.
   d. Simulate a patient alarm. (Perhaps by disconnecting the test lung.)
   e. Using the multimeter, ensure that there is a connection between pin 7 and pin 6.
   f. Silence the patient alarm by pressing the **ALARM** button on the front panel. (Figure 7-13.)
   Ensure that the alarm LED on the front panel lights up as shown in Figure 7-13, and that the alarm silence symbol is displayed on the screen, as shown on Figure 7-14.
   These show that GALILEO audible alarms are silenced.

Figure 7-13. The ALARM LED on the front panel

Figure 7-14. The alarm silence symbol on the LCD display

g. Using the multimeter, ensure that there is no electrical connection between pin 7 and pin 6.

6. Repeat step (5) on page 7-14, this time connecting the multimeter between pin 7 and pin 14. The results on the multimeter must be the exact opposites of those achieved in the first running of step (5).
7. Switch off GALILEO.

7.4.2.4 Reconfiguring the I:E relay port for hospital use

As it is now currently configured, the I:E relay port gives signals suitable for testing. You must now configure the I:E relay port to give signals suited to your hospital's requirements.

To do this, perform all the steps in *Configuring the Special port for testing* on page 7-11. However, this time, use your hospital's original settings, as displayed in Table 7-6, *Special interface original configuration*, on page 7-12.

Section

8 Checking electrical safety

WARNING

You must perform the electrical safety tests detailed in this section as a part of, and as instructed by, Section 4, *Overview of preventive maintenance and testing*.
In addition, to comply with EN 60601-1 you must also perform these electrical safety tests after:

- **Replacing the power supply**
- **Removing any ground (earth) contact from GALILEO**

8.1 Introduction

HAMILTON MEDICAL AG performs a set of electrical safety tests, according to Norm EN 60601-1, on all the ventilator and compressor units that it manufactures. HAMILTON MEDICAL AG performs these tests automatically, using the Metron Safety Analyzer (Figure A-3, *The Metron Safety Analyzer*, on page A-2).

As stated in the warning above, it is a legal necessity that you too, after performing a repair or adjustment that includes replacing the power supply or removing any of the internal earth connectors, perform electrical safety tests. In addition, HAMILTON MEDICAL recommends that even if you do not make a repair, you perform electrical safety tests when you perform routine maintenance.

The electrical safety tests you must perform are explained in this section. If you have an automated safety device such as the Metron used by HAMILTON MEDICAL AG, it is recommended that you also perform the more sophisticated, automated tests shown in Appendix G, *Automated electrical safety tests* ***in addition to the tests shown in this section***.

8.2 Checking grounding (earthing)

1. Identify the yellow/green ground wires in the enclosure. They are positioned near the expiratory valve. (Figure 8-1.)

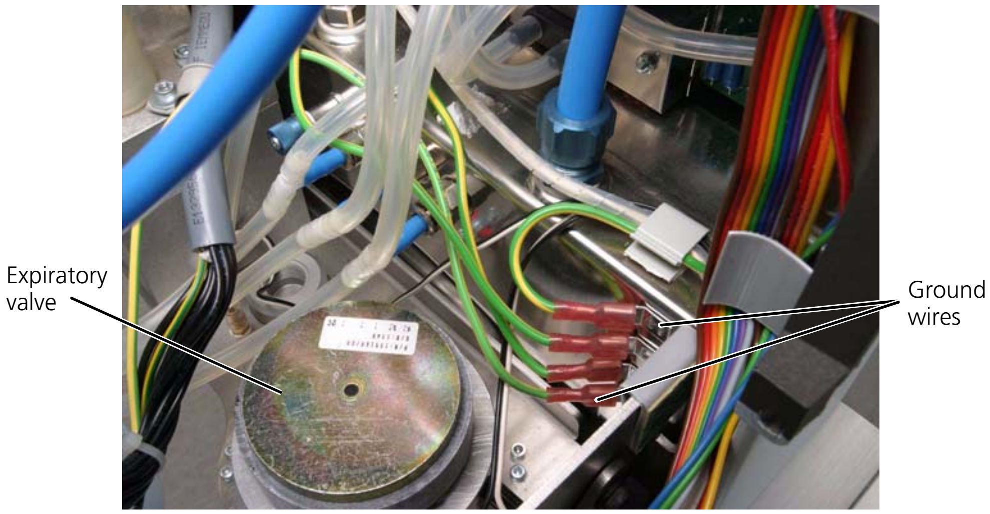


Figure 8-1. **Position of the ground wires**

2. Pull each wire, to test for tightness. (Figure 8-2.)

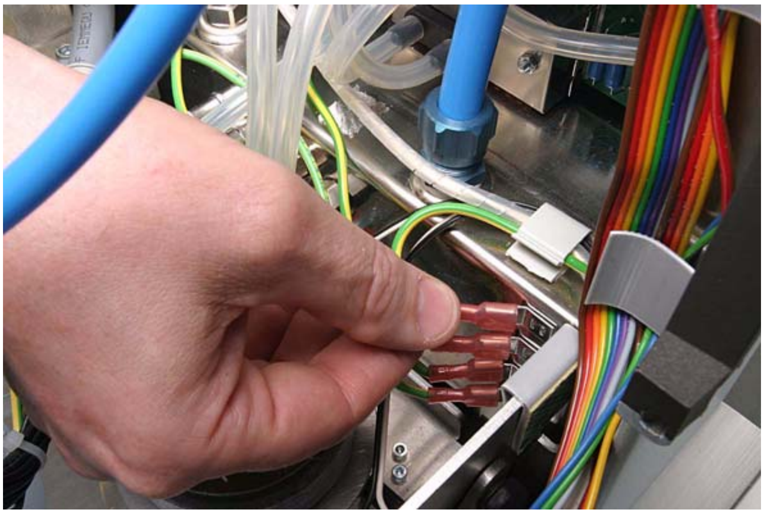


Figure 8-2. Testing for tightness

3. ***If you have opened the column***:
   a. Identify the yellow/green ground wires attached to the on/off switch, and test them for tightness. (Figure 8-3.)

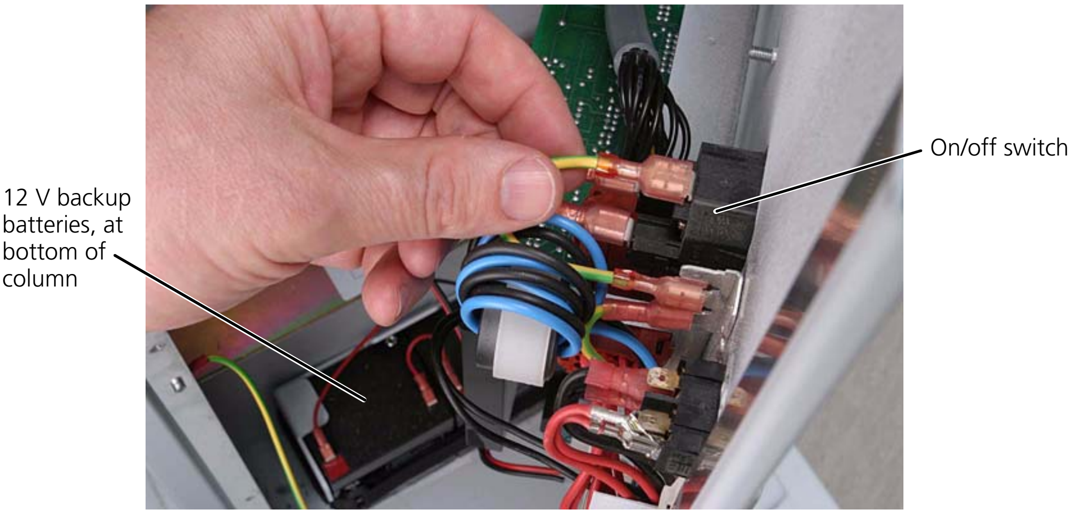


Figure 8-3. Checking the ground wires at the on/off switch

b. Identify and test the ground wire connecting the cover to the column. (Figure 8-4.)

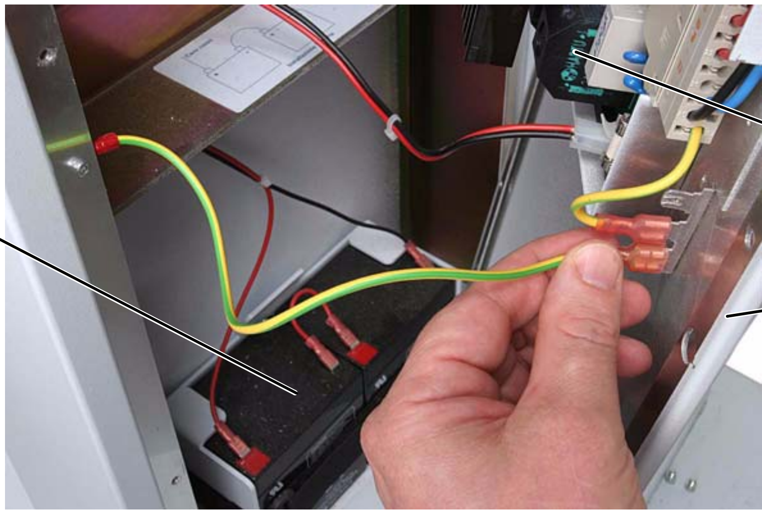


Figure 8-4. Checking the ground wire between column and column cover

4. Check the contact strips in the main housing. (Figure 8-5.) All must be securely in place.

WARNING

Do not touch the contact strip, as the sharp edges could result in injury.

Figure 8-5. Contact strip

5. Check the metal plate covering the cut-away in the rear enclosure that is used for the communications interface connector. It must be in place, and well fixed. (Figure 8-6.)

WARNING

This area must be covered with a blank plate if an interface is not fitted.

Figure 8-6. The fan and communication interface covers

6. Check the fan cover, including the wire mesh screen. (Figure 8-6.)

8.3 Electrical tests

For these tests you require a multi-meter, as specified in Appendix A.3.3, *Multi-meter*, on page A-2.

Check the resistance between the ground (earth) pin on GALILEO's power inlet socket, and other components, as shown in Table 8-1.

Check	Maximum acceptable resistance	Figure
Ground (earth) pin to: potential equalization terminal, if present.	$< 1\Omega$	Figure 8-7
Ground (earth) pin to: communication interface connector.		Figure 8-8
Ground (earth) pin to: tank overpressure valve cover.	$< 10\Omega$	Figure 8-9
Ground (earth) pin to: fan screen cover.		Figure 8-10

Table 8-1. Electrical tests

Figure 8-7. **Checking the earth pin to potential equalization terminal resistance**

Figure 8-8. **Checking earth pin to communication interface connector resistance**

Figure 8-9. **Checking the earth pin to tank overpressure valve cover resistance**

Figure 8-10. **Checking earth pin to fan screen cover resistance**

Section

9 Running Original or Upgrade 1 test software

WARNING

- **Read Section 4, *Overview of preventive maintenance and testing*, before performing any of the tests in this section.**
- **If one of the tests indicates that you must replace a part, do this immediately, and then repeat the complete series of tests. You can find much more information about replacing parts in Section 4, *Component details*.**

9.1 Introduction

This section describes each of the units comprising the test software found in the original GALILEO and in GALILEO Upgrade 1 (software versions 1 and 2). If you have a GALILEO Upgrade 2 (Gold or "Classic"), go to Section 10, *Running Upgrade 2 test software*.

Note
The test software in some very old units can differ very slightly from the descriptions in this section.

Before starting, be sure that you are familiar with *Typographic conventions* on page *Conventions-1*, and *Expressions* on page *Conventions-2*.

Consider also whether you must write a test report. Some hospitals require that you do this.

If you do not have a suitable form, you can photocopy and use the form named *GALILEO Original and Upgrade 1 Test Report* at the back of this manual.

9.2 Functions of the test software units

Units in the test software perform the following functions:

- They display information (mostly concerning revisions and versions of GALILEO software and hardware)
- They enable you to run checks on GALILEO hardware and software
- They enable you to calibrate GALILEO hardware and software

9.3 Structure of this section

In this section, test software units are described using the following headings:

Overview	Always included. Read if you wish.
Background information	Sometimes included. Read if you wish.
Preparation	Always included. ***You must read and perform these sections***.

Performing checks Performing calibrations	One or several of these headings always included. You must read and perform all sections of this kind. Hint: Once you are familiar with a test, follow the shaded "fast track".
Troubleshooting checks Troubleshooting calibrations	One or several of these headings always included. You must read and perform these sections only if you could not properly perform a test or calibration.
Completing this unit	Always included. ***You must read and perform this section***.

Note

In the troubleshooting sections, always perform the actions in the sequence specified.
Do not confuse the test-specific troubleshooting in this section, with Section 12, *General troubleshooting*.

9.4 Replacing parts

If one of the tests indicates that you must replace a part, do this immediately, and then repeat the complete series of tests.You can find much more information about replacing parts in Section 4, *Component details*.

9.5 Entering test software mode

To start the series of test units that comprise the test software, you must put GALILEO into test software mode. If you want to run the test software, do this now:

1. Connect the GALILEO to the mains power supply.
2. Switch on the GALILEO, while at the same time holding down both the **MANUAL** and the **100% O2** keys for 5 seconds. The opening screen is displayed.
3. Using the control knob, select **`Test Mode`**. Press the control knob. A screen displaying **`1: Microprocessor checks`** is displayed.
4. Turn the control knob to select the test unit you require. Press the control knob to activate the test unit you have selected.

Note

- You must perform the tests in numerical order.
- After starting the test software with an original GALILEO or an Upgrade 1, the audible alarm is stopped for 10 minutes, except for technical faults with the number TF9000 and higher. The alarm remains stopped, as long as you are actively using the GALILEO in test software mode.

9.6 Exiting the test software mode

To exit test software mode, select **Exit** in the main bar. The GALILEO switches to the start up screen.

TSW 1: GMP Selftest

TSW 1.1 Overview

This unit enables you to check the version or revision of:

- The GALILEO Main Processor (*GMP*)
- The GALILEO Control Processor (*GCP*)
- The GALILEO Press-&-Turn Processor (*GPT*)
- The GALILEO Interface Processor, where fitted (*GIP*)
- The *BIOS* and *operating system*
- The *control board*

In addition, you can check the date and the number of hours that the GALILEO has been in use.

Finally, when you start this unit, the GMP performs a self-test. You can also check the results of this.

TSW 1.2 Preparation

Activate **`TSW 1: GMP Selftest`**. You see a display similar to the following:

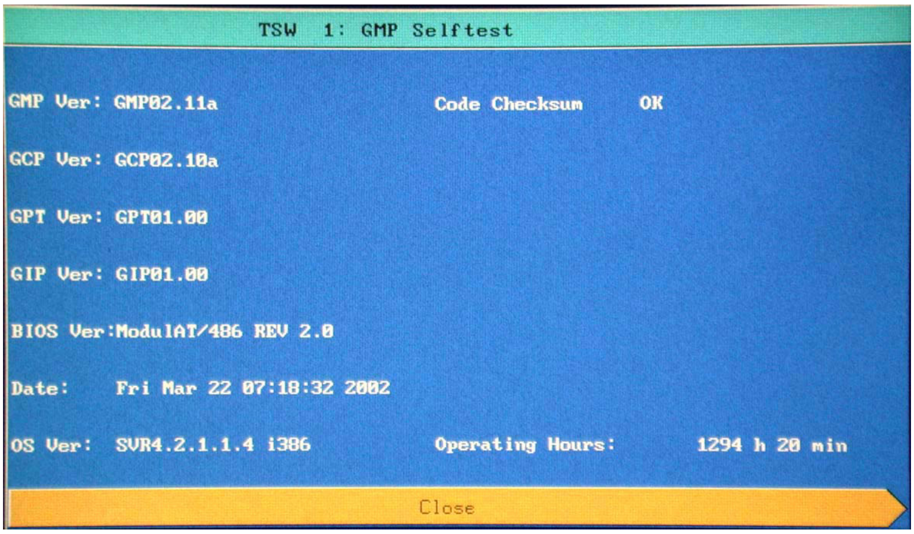


Figure 9-1. The `GMP Selftest` screen

TSW 1.3 Performing all checks

Field	Function	Check
`GMP ver:` `GCP ver:` `GPT ver:` `GIP ver:`	Display information about the software versions of the GMP, GCP, and GPT microprocessors. The GIP microprocessor is only included when the interface is fitted.	All software versions displayed must be compatible and should be the latest available. (If the software is not compatible, GALILEO will not ventilate.) See Appendix C, *GMP software/hardware compatibility*. If necessary, see the Service News, or general marketing information for information about upgrading.
`BIOS ver:`	Displays the BIOS version.	None.

Field	Function	Check
`Date:`	Displays the current date and time.	Must display the correct date and time.
`OS ver:`	Displays the operating system version.	None.
`Code Checksum`	Displays the result of the cyclical redundancy test of the GMP software code.	Must display `OK`.
`Operating hours:`	**Note** This field can be displayed in the local language. Displays the total number of hours the GALILEO has been operating.	The number of operating hours must seem reasonable. Typically, a new unit already has 20 to 50 operating hours.

Troubleshooting all checks

Problem Area	Symptom	Action
`GMP ver:` `GCP ver:` `GPT ver:` `GIP ver:`	Software versions not latest available.	Consider upgrading. For the latest information, see the HAMILTON MEDICAL AG Partner Website (http://www.hamilton-medical.ch/partner-site).
	Software versions not compatible.	Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).
`Date:`	Date or time is not correct.	• Reset the date or time in the configuration menu, as described in the operators' manual for your GALILEO. • If the setting remains unstable, replace the 3 V battery, if fitted. (See Section 11.8.6, *Replacing the 3 V "button" battery*, on page 11-30.) • If the date setting still remains unstable, replace the GMP assembly and repeat TSW 1.3. (See Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.)
`Code Checksum:`	`OK` is not displayed	Change the GMP software. (See Section 11.19.5, *Replacing the GMP CompactFlash*, on page 11-101.)

Problem Area	Symptom	Action
`Operating hours:`	Number of hours unreasonably low	If you have exchanged the GMP program carrier (the GMP CompactFlash), you must set the operating hours to the value of the original board. You do this in the **`Clock`** window, accessed under the **`Configuration`** menu.
	Number of hours unreasonably high	The most likely reason is that the GMP software was changed, and the number of operating hours was wrongly set after the change. Because it is only possible to set the number of operating hours once, it is not simple to correct this fault. Two courses of action are possible: • Obtain or create a record of the GALILEO's current configuration. Add to this a note that the operating hours displayed are higher than those really performed. • Replace the GMP program carrier, and set the operating hours again. You do this in the **`Clock`** window, accessed under the **`Configuration`** menu.

TSW 1.4 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`** (or the local language equivalent).

TSW 2: GPT-GMP Communication

TSW 2.1 Overview

This unit shows the result of a *GPT* check initiated in *TSW 1: GMP Selftest*. It also automatically performs communication checks between the *GPT* and the *GMP* microprocessors immediately the unit is activated.

In this test unit you also manually check:

- The alarm LED
- The LCD display brightness
- The *emergency buzzer alarm*
- The alarm relay for the communication interface

Note
You cannot perform any of the manual checks until the automatic communication checks are complete. This takes about 10 s.

TSW 2.2 Preparation

Activate **`TSW 2: GPT-GMP Communication`**. You see a display similar to the following:

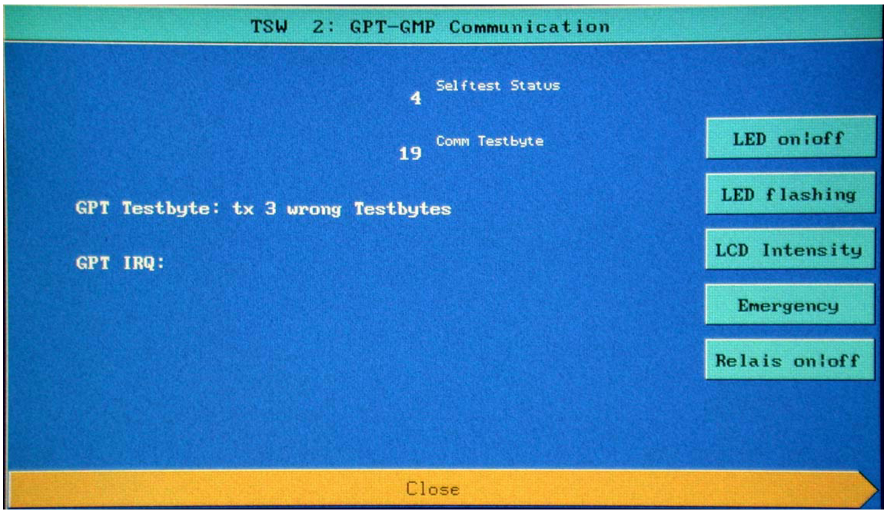


Figure 9-2. The `GPT-GMP Communication` screen

When you first open the screen, you see the message **`tx 3 wrong Testbytes`** for a few seconds.

TSW 2.3 Performing the GPT and GMP checks

Field	Function	Check
`GPT Testbyte:`	Displays the status and result of an incrementing communication check between the GPT and GMP.	Must display **`Done`**. (This takes about 5 seconds.)
`GPT IRQ:`	Displays the status and result of a communication interrupt check between the GPT and GMP.	Must display **`Done`**. (This takes about 10 seconds.)
`Selftest Status`	Displays the result of the GPT selftest.	Must display the number **`4`**. Any other number indicates that the GPT selftest was not successful.
`Com Testbyte`	Displays the current value of a communication check that runs continuously when the ventilator is functioning.	The value must increment (count upwards) in steps of two. The numbers displayed can be odd or even. (In other words, 1, 3, 5...31 or 2, 4, 6...30.) (Incrementing only begins when **`GPT Testbyte:`** and **`GPT IRQ:`** both display **`Done`**.)

Troubleshooting the GPT and GMP checks

Problem Area	Symptom	Action
`GPT Testbyte:`	**`Done`** is not displayed.	Try replacing each of the following items in turn, repeating TSW 2.3 after each replacement: • *GMP* assembly. (Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.) • *GPT. (*Section 11.20.5, *Replacing the GPT controller*, on page 11-103.) **Note** If you replace an item and successfully repeat TSW 2.3, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.
`GPT IRQ:`	**`Done`** is not displayed.	
`Selftest Status`	A number other than **`4`** is displayed.	Try replacing the *GPT* controller, repeating TSW 2.3 after replacement. *(*Section 11.19.5, *Replacing the GMP CompactFlash*, on page 11-101.) **Note** If you replace an item and successfully repeat TSW 2.3, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

Problem Area	Symptom	Action
`Com Testbyte`	Does not repeatedly increment (count) to **30** or **31**.	Try replacing each of the following items in turn, repeating TSW 2.3 after each replacement: • *GMP* assembly. (Section 11.19.5, *Replacing the GMP CompactFlash*, on page 11-101.) • *GPT microprocessor. (See* Section 11.20.5, *Replacing the GPT controller*, on page 11-103.) **Note** If you replace an item and successfully repeat TSW 2.3, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 2.4 Performing the LED, LCD, and relay checks

Button	Function	Action	Check
`LED on:off`	Switches the **ALARM** LED on the front panel on and off.	1. Activate **`LED on:off`**.	2. The **ALARM** LED on the left of the key on the front panel must switch on (Figure 9-3, *The ALARM LED on the front panel*, on page 9-9).
		3. Deactivate **`LED on:off`**.	4. The **ALARM** LED must switch off.
`LED flashing`	Causes the **ALARM** LED on the front panel to flash and to stop flashing.	1. Activate **`LED flashing`**.	2. The **ALARM** LED must flash.
		3. Deactivate **`LED flashing`**.	4. The **ALARM** LED must stop flashing.
`LCD Intensity`	Causes the LCD display to dim and brighten on some units.	**Note** This function is not implemented on older units.	
		1. Activate **`LCD Intensity`**.	2. The LCD display must dim.
		3. Deactivate **`LCD Intensity`**.	4. The LCD display must return to its original brightness.
`Emergency`	Switches the emergency buzzer on and off.	**Note** The emergency buzzer alarm makes a high frequency sound. It functions independently of the loudspeaker.	
		1. Activate **`Emergency`**.	2. The emergency buzzer must sound, and you must hear the “click” of the 15 V relay closing.
		3. Deactivate **`Emergency`**.	4. The emergency buzzer must stop sounding, and you must hear the “click” of the 15 V relay opening.

Button	Function	Action	Check
`Relais on:off`	Switches on and off the relay that operates the external nurse alarm.	**Note** You can only perform this check fully if you have an external nurse alarm connected to the external interface.	
		1. Activate **`Relais on:off`** several times.	2. You must hear the click of the alarm relay opening and closing. 3. If connected, the external nurse alarm must operate.

Figure 9-3. The ALARM LED on the front panel

Troubleshooting the LED, LCD, and relay checks

<table>
<tr><th>Problem Area</th><th>Symptom</th><th>Action</th></tr>
<tr><td><code>LED on:off</code></td><td>The ALARM LED does not switch on and off.</td><td rowspan="2">Verify that the flat cables going from the keypad to the connector board are properly in place, then repeat TSW 2.4. (The cable connectors on the connector board are numbered P15 and P416.)
Try replacing each of the following items in turn, repeating TSW 2.4 after each replacement:
Front panel keys. (See Section 11.16.5, Replacing the front panel keys, on page 11-86.)
The connector board. (See Section 11.10.6, Replacing the connector board, on page 11-40.)
Note
If you replace an item and successfully repeat TSW 2.4, you must then perform all test software units, starting with TSW 1: GMP Selftest, on page 9-3.</td></tr>
<tr><td><code>LED flashing</code></td><td>The ALARM LED does not flash and stop flashing.</td></tr>
<tr><td rowspan="2"><code>Emergency</code></td><td>The emergency buzzer alarm does not turn on and turn off.</td><td rowspan="3">Verify that all connections to the control board are properly in place. (See Figure 11-57, Control board PN 155461 in GALILEO, with all connections in place, on page 11-55.)
Verify that all connections to the connector board are properly in place. (See Figure 11-44, Cable connections to connector board PN 155256 Revs 0 to 8, on page 11-42.)</td></tr>
<tr><td>The 15 V relay does not click open and click close.</td></tr>
<tr><td rowspan="2"><code>Relais on:off</code></td><td>The alarm relay does not click open and click close.</td></tr>
<tr><td>The external nurse alarm does not operate.</td><td>Verify that the cable from the connector board to the interface connector on the rear of the GALILEO is in place and is properly connected.</td></tr>
</table>

TSW 2.5 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate `Close` (or the local language equivalent).

TSW 3: Display

TSW 3.1 Overview

This unit displays:

- The version of the *VGA graphics card*
- The version of the VGA *BIOS*

The test unit enables you to check:

- The LCD display colors
- The LCD display backlight
- The LCD display pixel alignment
- The dc/ac board

TSW 3.2 Preparation

Activate **`TSW 3: Display`**. You see a display similar to the following:

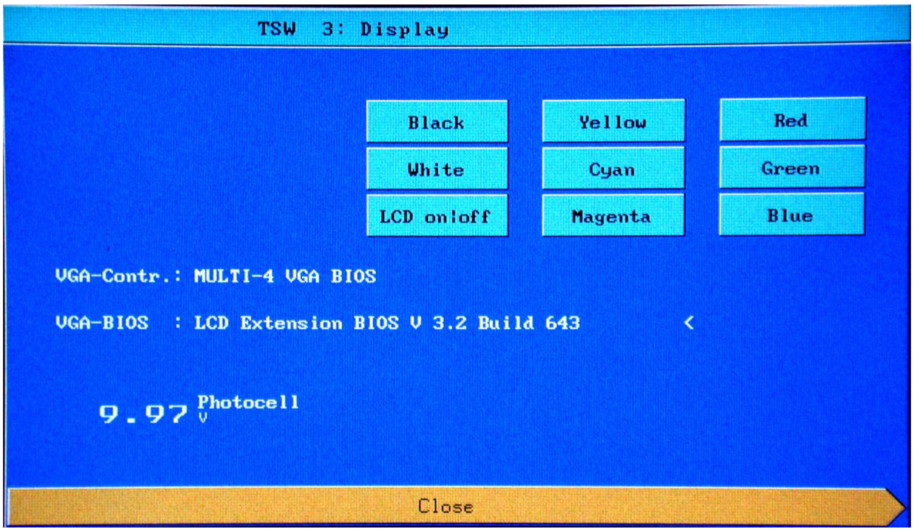


Figure 9-4. The `Display` screen

TSW 3.3 Performing the VGA and BIOS version checks

Field	Function	Check
`VGA-Contr.:`	Displays the version of the Video Graphics Adapter (*VGA graphics card*) used by the display.	None.
`VGA-BIOS:`	Displays the version of the BIOS of the VGA card.	None.
`Photocell`	Not currently used. No check required.	

TSW 3.4 Performing the LCD display color checks

Button	Function	Action	Check
`Black` **`Yellow`** and so on	Each button tests the ability of the LCD display to display one color. **Note** The alarm symbol at the bottom right of the screen does not change color.	1. Activate a color button. 4. Deactivate the button. 6. Repeat for all buttons	2. The screen must show the appropriate color. 3. There must be no more than a cluster of 4 discolored pixels in any one place. 5. The screen must show the normal screen. 7. Results must alternate between the appropriate color and the normal screen.
`LCD on:off`	Enables you to check that the LCD display backlight can be turned off and on.	1. Activate **`LCD on:off`**. 3. Deactivate **`LCD on:off`**.	2. The display must appear dark. 4. The display must show the normal screen.

Troubleshooting the LCD display color checks

<table>
<tr><th>Problem Area</th><th>Symptom</th><th>Action</th></tr>
<tr><td rowspan="2">Black
Yellow
and so on</td><td>There a total of more than 4 discolored pixels in one place.</td><td>Replace the LCD display and repeat TSW 3.4. (See Section 11.24.6, Replacing the LCD display and backlights, on page 11-127.)

Note
If you replace the LCD display and successfully repeat TSW 2.3, you must then perform all test software units, starting with TSW 1: GMP Selftest, on page 9-3.</td></tr>
<tr><td>One or more colors does not display.</td><td rowspan="2">• Check that the wide ribbon cable attached to the top of the VGA graphics card is correctly positioned. (This is at the top of the GMP assembly.)
• Try replacing each of the following items in turn, repeating TSW 3.4 after each replacement:
  • dc/ac board. The converter must be the Hitachi version, PN 155317. If it is the TDK version, PN 155415, you must replace it. (See Section 11.12.5, Replacing the dc/ac board, on page 11-63.)
  • GMP assembly. (See Section 11.11.6, Replacing the control board and GMP assembly, on page 11-52.)
  • LCD backlight. (See Section 11.24.6, Replacing the LCD display and backlights, on page 11-127.)
  • LCD display. (See Section 11.24.6, Replacing the LCD display and backlights, on page 11-127.)

Note
If you replace an item and successfully repeat TSW 3.4, you must then perform all test software units, starting with TSW 1: GMP Selftest, on page 9-3.</td></tr>
<tr><td rowspan="2">LCD on:off</td><td>LCD does not function.</td></tr>
<tr><td>LCD only partially lights up.</td><td>• Ensure that both LCD backlights are properly connected to the dc/ac board. (See Section 4.20, LCD display and backlights, on page 4-51.)
• Replace the faulty LCD backlight and repeat TSW 3.4.(See Section 11.24.6, Replacing the LCD display and backlights, on page 11-127.)

Note
Perform all test software units, starting with TSW 1: GMP Selftest, on page 9-3.</td></tr>
</table>

TSW 3.5 Completing this unit

1. Fill in the results of this test unit in your test report.

2. Activate **`Close`** (or the local language equivalent).

TSW 4: User Interface

TSW 4.1 Overview

This unit enables you to check:

- The push-&-turn function of the monitoring knob
- The push-&-turn function of the control knob
- The three alarm-priority-level sounds generated by the loudspeaker
- The functions of all keys on the front keypad

TSW 4.2 Preparation

Activate **`TSW 4: User Interface`**. You see a display similar to the following:

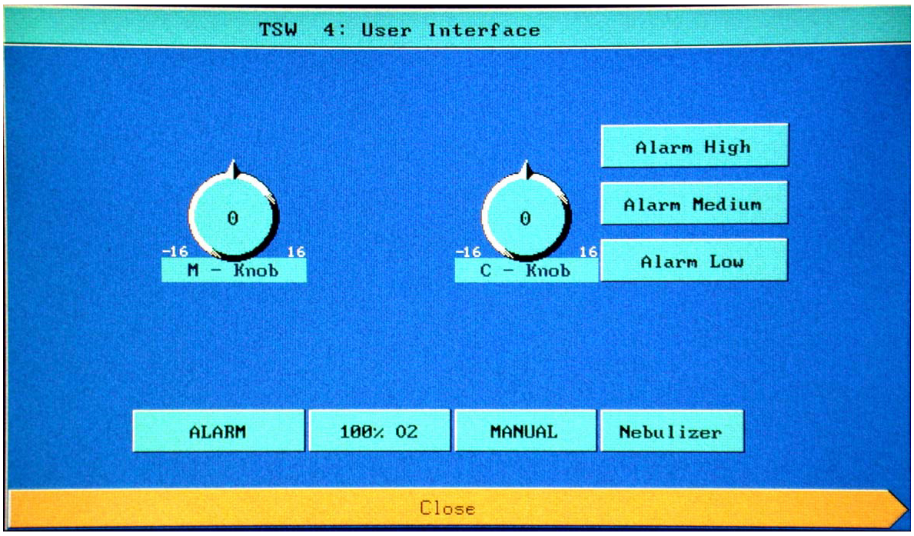


Figure 9-5. The `User Interface` screen

TSW 4.3 Performing the monitoring knob and control knob checks

Field	Function	Action	Check
`M - Knob` "knob"	Enables a check of the pressing and turning functions of the monitoring knob.	1. Activate the `M - Knob` "knob" on the LCD display by using the control knob in the normal way.	
		2. Slowly turn the monitoring knob on the front panel 16 clicks to the right.	3. Verify that the digital count on `M - Knob` matches each movement of the monitoring knob.
		4. Return the `M - Knob` "knob" to the neutral position (by turning the monitoring knob).	
		5. Turn the monitoring knob 16 clicks to the left.	6. Verify that the digital count on `M - Knob` matches each movement of the monitoring knob, and is negative.
`C - Knob` "knob"	Enables a check of the pressing and turning functions of the control knob.	1. Activate the `C - Knob` "knob" on the LCD display by using the control knob in the normal way.	
		2. Slowly turn the control knob on the front panel 16 clicks to the right.	3. Verify that the digital count on `C - Knob` matches each movement of the control knob.
		4. Return the `C - Knob` "knob" to the neutral position (by turning the control knob).	
		5. Turn the control knob 16 clicks to the left.	6. Verify the digital count on `C - Knob` matches each movement of the control knob, and is negative.

Troubleshooting the monitoring knob and control knob checks

Problem Area	Symptom	Action
Monitoring knob Control knob	Some or all of the 32-click range does not function.	• Verify that the very thin ribbon cable from the control knob encoder to the *connector board* is properly connected. (See Figure 11-43, *Removing a ribbon cable to a P&T-knob encoder*, on page 11-41.) • Replace the encoder and repeat TSW 4.3. (See Section 11.30.6, *Replacing an encoder*, on page 11-189.) **Note** If you replace the control knob encoder and successfully repeat TSW 4.3, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 4.4 Performing the audible alarm checks

Button	Function	Action	Check
Alarm High	Enables you to check the high (most serious) audible alarm tone.	**Note** If you do not touch any key for 10 minutes, an **Alarm High** can sound due to an alarm situation. This overrides any **Alarm Medium** or **Alarm Low** that might possibly be active at the time.	
		1. Activate **Alarm High**. (You cannot deactivate this button.)	2. You must hear a series of 3 tones, followed by 2 tones. This series is continuously repeated. (Figure 9-6.)
Alarm Medium	Enables you to check the medium (moderately serious) audible alarm tone.	1. Activate **Alarm Medium**. (You cannot deactivate this button.)	2. You must hear a series of 3 tones, repeated after 25 s, and then after every 30 s. (Figure 9-6.) See note above.
Alarm Low	Enables you to check the low (least serious) audible alarm tone.	1. Activate **Alarm Low**. (You cannot deactivate this button.)	2. You must hear two tones. These are not repeated. (Figure 9-6.) See note above.

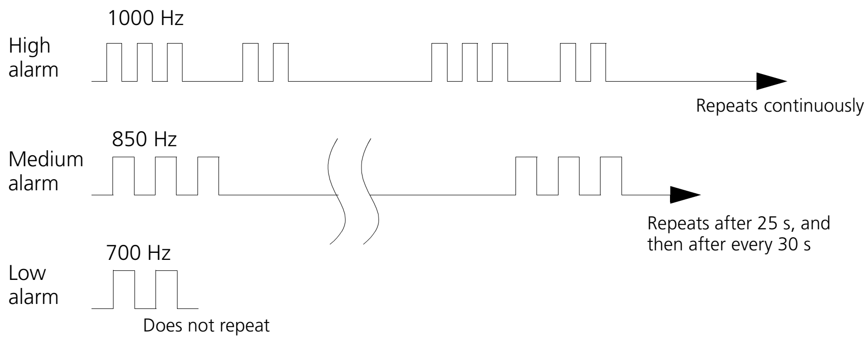


Figure 9-6. The high, medium and low alarm tones

Troubleshooting the audible alarm checks

Problem Area	Symptom	Action
Alarm High **Alarm Medium** Alarm Low	Does not function as described in Figure 9-6.	• Verify that the loudspeaker is connected. • Verify that all cables to the *control board* are properly connected. (See Figure 11-56, *Control board PN 155461 connections*, on page 11-54.) • Verify that all cables to the *GMP* assembly are properly connected.

TSW 4.5 Performing the front-panel key checks

Button	Function	Action	Check
`ALARM`	Enables you to test the **ALARM** key.	1. Press and hold the **ALARM** key on the front panel keypad.	2. Ensure the `ALARM` button on the LCD display appears depressed as long as the key is pressed.
`100% O2`	Enables you to test the **100% O2** key.	1. Press and hold the **100% O2** key on the front panel keypad.	2. Ensure the `100% O2` button on the LCD display appears depressed as long as the key is pressed.
`MANUAL`	Enables you to test the **MANUAL** key.	1. Press and hold the **MANUAL** key on the front panel keypad.	2. Ensure the `MANUAL` button on the LCD display appears depressed as long as the key is pressed.
`NEBULIZER`	Enables you to test the (optional) nebulizer key.	**Note** This key is always present on the far right of the keypad. However, it is only labelled if the nebulizer option is included in the GALILEO. Where present, it is labelled with the nebulizer symbol: 	
		1. Press and hold the nebulizer key on the front panel keypad.	2. Ensure the `NEBULIZER` button on the LCD display appears depressed as long as the key is pressed.

Troubleshooting the front-panel key checks

Problem Area	Symptom	Action
`ALARM` `100% O2` MANUAL NEBULIZER	Button on LCD display does not appear depressed.	• Verify that the two very thin ribbon cables from the keypad to the *connector board* are properly connected. (See Figure 11-43, *Removing a ribbon cable to a P&T-knob encoder*, on page 11-41.) • Replace the keypad and repeat TSW 4.5. (See Section 11.16.5, *Replacing the front panel keys*, on page 11-86.) **Note** If you replace the keypad and successfully repeat TSW 4.5, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 4.6 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate `Close` (or the local language equivalent).

TSW 5: GCP-GMP Communication

TSW 5.1 Overview

This unit enables you to check the results of a series of communication checks between the *GCP* and the *GMP*.

TSW 5.2 Preparation

Activate **`TSW 5: GCP-GMP Communication`**. You see a display similar to the following:

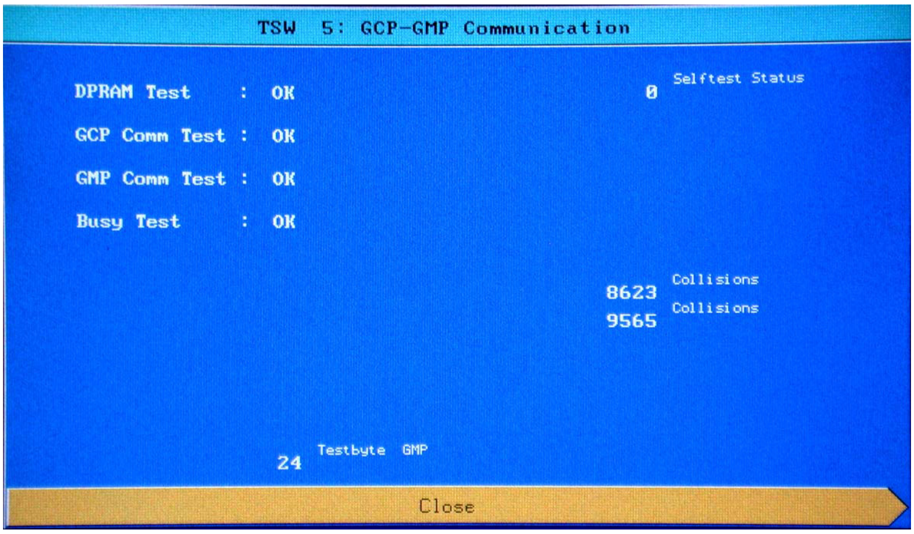


Figure 9-7. The `GCP-GMP Communication` screen

TSW 5.3 Performing all checks

Field	Function	Check
`DPRAM Test:`	Displays the results of a check for bad cells in the dual-ported RAM (DPRAM).	Must display **`OK`**.
`GCP Comm Test:`	Displays the result of a communication check from the GCP to the GMP.	Must display **`OK`**.
`GMP Comm Test:`	Displays the result of a communication check from the GCP.	Must display **`OK`**.
`Busy Test:`	Displays the result of a check in which the GMP and GCP write and read to the same address in the DPRAM at the same time. This activity causes addressing collisions.	Must display **`OK`** after a short time.
`Selftest Status`	Displays the result of a check the GCP performs on itself at startup.	Must display **`0`**.
`Collisions`	Displays the number of collisions that took place in the **`Busy Test`** (see above).	A value of 1000 or greater must be displayed in one or both of these fields.
`Collisions`		

Field	Function	Check
`Testbyte GMP`	Displays the status and result of an incrementing communication check between the GPT and GMP.	The value displayed must increment (count upwards) from approximately 0 to approximately 255 in steps of 20. (The starting number is from 0 to 20. The finishing number is from 235 to 255.)

Troubleshooting all checks

Problem Area	Symptom	Action
`DPRAM Test:` `GCP Comm Test:` `GMP Comm Test:` `Busy Test:`	`OK` is not displayed. A time-out error message is displayed.	Try replacing each of the following items in turn, repeating TSW 5.3 after each replacement: • *GCP*. (*See* Section 11.18.5, *Replacing the GCP EPROM*.) • *GMP* assembly. (See Section 11.11.6, *Replacing the control board and GMP assembly*.) • The *control board*. (See Section 11.11.6, *Replacing the control board and GMP assembly*.) **Note** If you replace an item and successfully repeat TSW 5.3, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.
`Selftest Status`	`0` is not displayed.	Try replacing each of the following items in turn, repeating TSW 5.3 after each replacement: • *GCP*. (*See* Section 11.18.5, *Replacing the GCP EPROM*, on page 11-98.) • The *control board*. (*See* Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.) If this fails, contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you replace an item and successfully repeat TSW 5.3, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.
`Collisions` `Collisions`	A value of 1000 or greater is not displayed in one or both of these fields.	Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Problem Area	Symptom	Action
`Testbyte GMP`	Does not increment (count upwards).	Try replacing each of the following items in turn, repeating TSW 5.3 after each replacement: • *GCP* EPROM. (See Section 11.18.5, *Replacing the GCP EPROM*, on page 11-98.) • *GMP* assembly. *(See* Section 11.11.6, *Replacing the control board and GMP assembly*.) • *The control board. (See* Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.) **Note** If you replace an item and successfully repeat TSW 5.3, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 5.4 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`** (or the local language equivalent).

TSW 6: A/D Conversion

TSW 6.1 Overview

In this test unit you check the performance of analog-digital converter U24 on the *control board*.

TSW 6.2 Background information

The test screen displays details of 16 analog signals from multiplexer U34 (on the control board). Each channel is converted by analog-digital converter U24, and the result displayed on the screen. In this test unit you confirm the performance of the AD converter by checking just four of these values.

TSW 6.3 Preparation

1. Activate **`TSW 6: A/D Conversion`**. You see a display similar to the following:

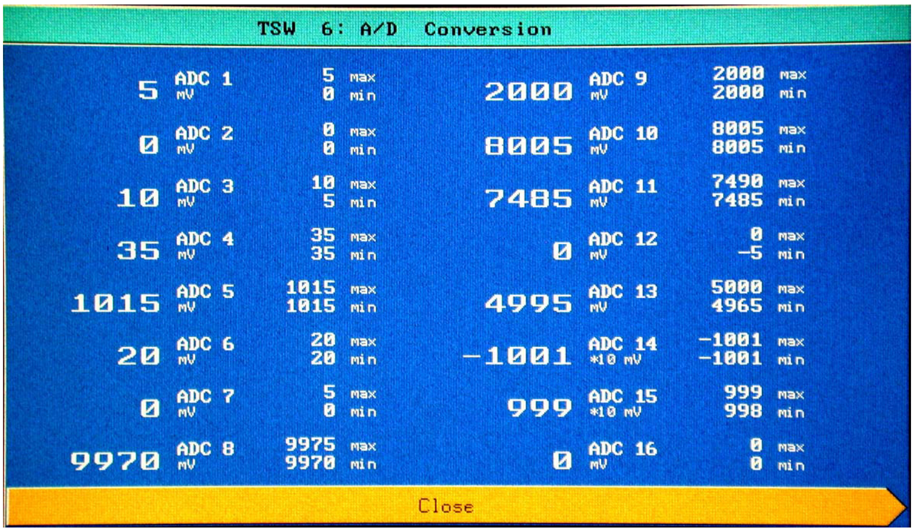


Figure 9-8. The `A/D Conversion` screen

TSW 6.4 Performing all checks

Field	Function	Check
`ADC 1`	Analog-digital channel 1. Displays the voltage from the *Ppat* pressure sensor.	None.
`ADC 2`	Analog-digital channel 2. Displays the voltage from the *Paw* pressure sensor.	None.
`ADC 3`	Analog-digital channel 3. Displays the voltage from the *Paux* pressure sensor.	None.

Field	Function	Check
`ADC 4`	Analog-digital channel 4. Displays the voltage from the *dP servo differential pressure sensor*.	None.
`ADC 5`	Analog-digital channel 5. Displays the square root (calculated analogically) of a voltage indicating gas flow from the *inspiratory (servo) valve*. This value is used internally, by GALILEO.	None.
`ADC 6`	Analog-digital channel 6. Displays the voltage from the *dP Flow Sensor differential pressure sensor*.	None.
`ADC 7`	Analog-digital channel 7. Displays the voltage from the *oxygen cell*.	None.
`ADC 8`	Analog-digital channel 8. Displays the voltage from the photo cell. This feature is not fully implemented.	None.
`ADC 9`	Analog-digital channel 9. Displays the voltage of the analog signal to the *inspiratory (servo) valve*.	None.
`ADC 10`	Analog-digital channel 10. Displays the voltage of the analog signal to the *expiratory valve*.	None.
`ADC 11`	Analog-digital channel 11. Displays the value of the (nominal) 15 V power supply to the GALILEO. However, because of display limitations, the value shown on screen is half of the real value supplied.	None.
`ADC 12`	Analog-digital channel 12. Displays the voltage supplied to the CompactFlash card. This is nominally 12 V. However, because of display limitations, the value shown on screen is half of the real value supplied.	None.
`ADC 13`	Analog-digital channel 13. Displays the value of the (nominal) 5 V power supply to the GALILEO.	The **`max`** and **`min`** values displayed must both be in the range: **`4850`** to **`5250`**.
`ADC 14`	Analog-digital channel 14. Displays the value of the (nominal) -10 V supply to the pressure sensors.	The **`max`** and **`min`** values displayed must both be in the range: **`-990`** to **`-1010`**.
`ADC 15`	Analog-digital channel 15. Displays the value of the (nominal) 10 V power supply to the *inspiratory (servo) valve*.	The **`max`** and **`min`** values displayed must both be in the range: **`990`** to **`1010`**.

Field	Function	Check
`ADC 16`	Analog-digital channel 16. Displays the ground voltage.	The **`max`** and **`min`** values displayed must both be in the range: **`-10`** to **`10`**.

Troubleshooting all checks

<table>
<tr><th>Problem Area</th><th>Symptom</th><th>Action</th></tr>
<tr><td><code>ADC 12</code></td><td rowspan="4">Value is out of range.</td><td rowspan="4">Check all connections to the connector board. In particular, make sure that the cable connecting the power supply in the column is properly in place. (See Figure 11-44, Cable connections to connector board PN 155256 Revs 0 to 8, on page 11-42.)
Try replacing each of the following items in turn, repeating this TSW 6.4 after each replacement:
• Cable 9 (power supply to connector board).
• Other cables.
• Connector board. (See Section 11.10.6, Replacing the connector board, on page 11-40.)
• Control board. (See Section 11.11.6, Replacing the control board and GMP assembly, on page 11-52.)
• Power supply board. (See Section 11.29.8, Replacing the power supply, on page 11-179.)
Note
If you replace an item and successfully repeat TSW 6.4, you must then perform all test software units, starting with TSW 1: GMP Selftest, on page 9-3.</td></tr>
<tr><td><code>ADC 14</code></td></tr>
<tr><td><code>ADC 15</code></td></tr>
<tr><td><code>ADC 16</code></td></tr>
</table>

TSW 6.5 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`** (or the local language equivalent).

TSW 7: D/A Conversion

TSW 7.1 Overview

In this test unit you check the performance of digital-analog converter U33, located on the *control board*.

TSW 7.2 Background information

When you activate this unit, the screen displays an input “knob” that you “turn” using the control knob. This action controls two digital signals that the *GCP* sends to DAC U33. (Figure 9-9.)

DAC U33 changes these digital signals to analog signals, and sends them to the inspiratory and expiratory valves, and to ADC U24.

ADC U24 measures the analog signals from U33, and sends corresponding digital signals to the screen (through the GCP), where they are displayed as **`ADC 9`** and **`ADC 10`**.

Because ADC U24 was tested in 6:A/D Conversion, you know that the **`ADC 9`** and **`ADC 10`** readings shown on the screen are an accurate indication of the analog values they represent.

You might like to compare Figure 9-9 with the large schematics of the control board in Appendix I, *Schematics*.

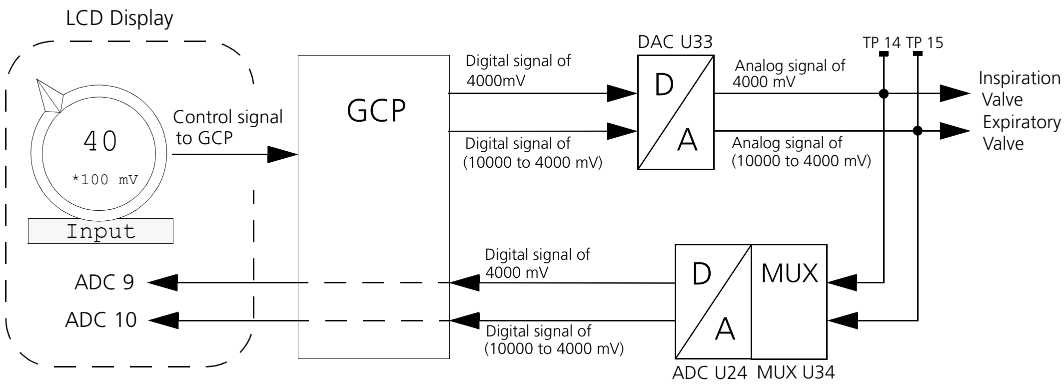


Figure 9-9. Sending digital signals corresponding to 4000 mV and 6000 mV to the inspiratory and expiratory valves

TSW 7.3 Preparation

Activate **`TSW 7: D/A Conversion`**. You see a display similar to the following:

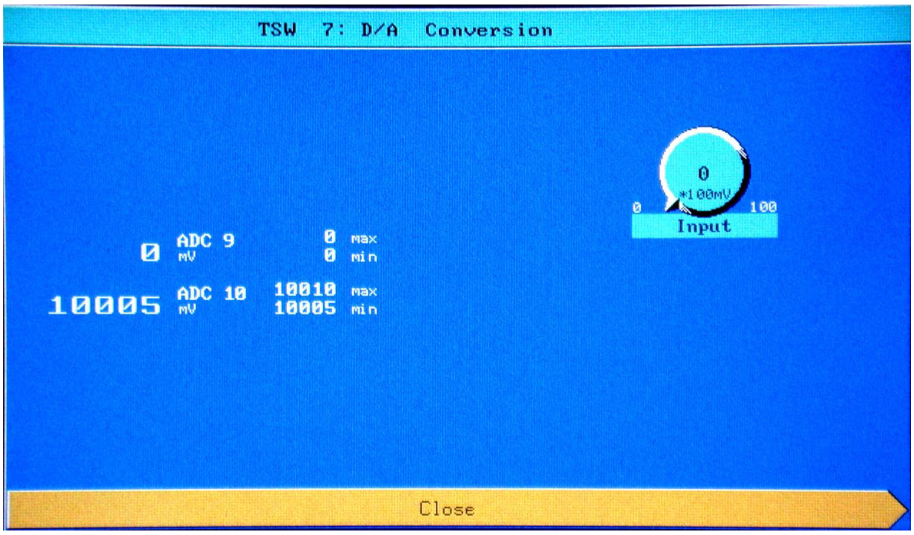


Figure 9-10. The `D/A Conversion` screen

TSW 7.4 Performing all checks

Field	Function	Action	Check
`Input` "knob"	Enables you to send a digital value to digital-analog converter U33.	1. Activate the **`Input`** "knob" with the control knob in the normal way. 2. Turn the **`Input`** "knob" so that it displays **`0`**. Perform the **`ADC 9`** and **`ADC 10`** checks for **`Input`** "knob" **`0`**. (Table 9-1 on page 9-27.) 3. Repeat for values of **`40`** and **`100`**.	
`ADC 9`	Displays the value of the analog signal output from digital-analog converter U33, after that signal is converted back to digital. (This equals the signal set at the **`Input`** "knob" (plus or minus any inaccuracies resulting from the digital-analog-digital conversion.)		As described in the grey area above, the values displayed for **`ADC 9`** must be as shown on Table 9-1 on page 9-27.
`ADC 10`	Displays the value 10000, minus the value set at the **`Input`** "knob" (plus or minus any inaccuracies resulting from the digital-analog-digital conversion.)		As described in the grey area above, the values displayed for **`ADC 10`** must be as shown on Table 9-1 on page 9-27.

`Input` “knob”	`ADC 9`	`ADC 10`
`0`	`-10` to `10`	`9800` to `10200`
`40`	`3800` to `4200`	`5800` to `6200`
`100`	`9800` to `10200`	`-10` to `10`

Table 9-1. `ADC 9` and `ADC 10` values

Troubleshooting all checks

Problem Area	Symptom	Action
`ADC 9` `ADC 10`	Values out of range.	Replace the *control board* and repeat *TSW 7.4*. (See Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.) **Note** If you replace the control board and successfully repeat TSW 7.4, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 7.5 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`** (or the local language equivalent).

TSW 8: Zero and Fullscale

TSW 8.1 Overview

This test unit enables you to calibrate the zero and "full scale" points of most pressure sensors.

The only exceptions are the *dP Flow Sensor* full-scale calibration, which can only be checked, and the *dP mixer* full-scale calibration, which is performed in TSW 10.5, *Performing the mixer gain calibration*, on page 9-49.

Note
In this context, "full scale" does not necessarily mean the highest possible point on the calibration scale. It means a point far enough removed from the zero point to enable an accurate calibration to take place.

TSW 8.2 Preparation

1. Disconnect from the GALILEO:
   - Patient tubing system
   - Air and oxygen supply
2. Disconnect the tubing from the *mixer* block. (Figure 9-11.)

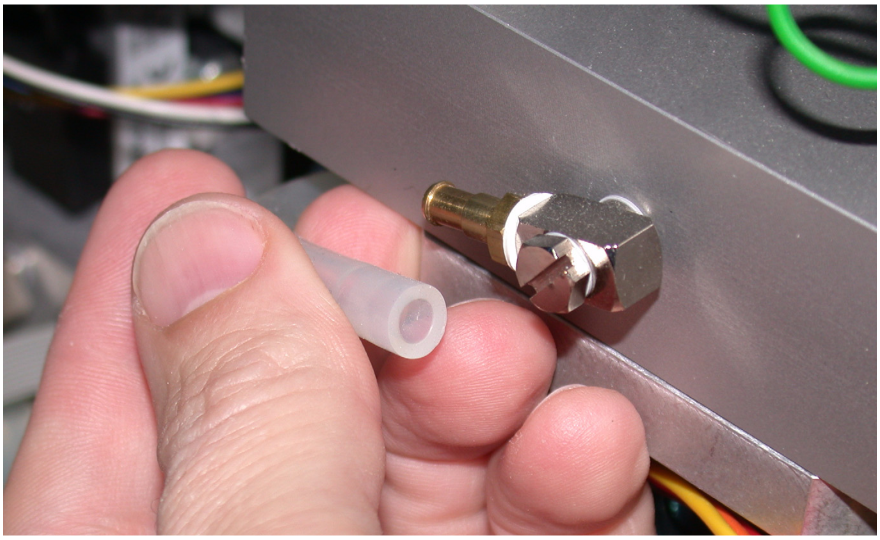


Figure 9-11. The tubing disconnected from the mixer block

3. Locate the potentiometers and test pins that you will use to adjust the pressure sensors. These are positioned on:
   - The servo board. This is located to one side of the inspiratory valve as shown on Figure 9-12. The test pins and potentiometers are identified on Figure 9-13.
   - The sensor board. This is located under the mixer, as shown on Figure 9-14. The test pins and potentiometers are identified on Figure 9-15.

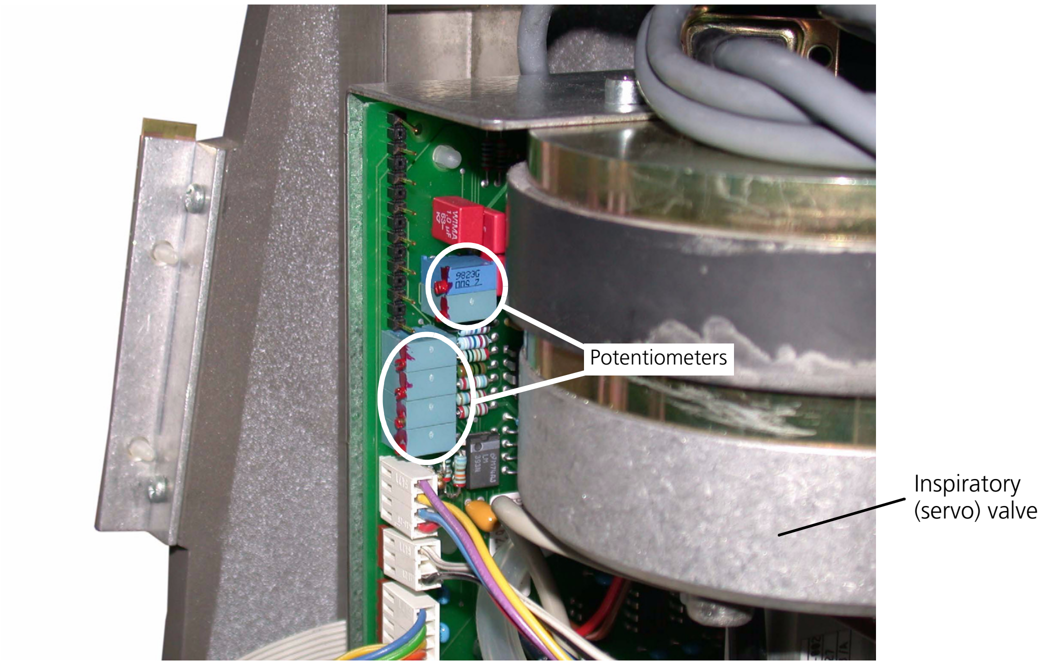


Figure 9-12. **Location of the potentiometers on the inspiratory (servo) valve board**

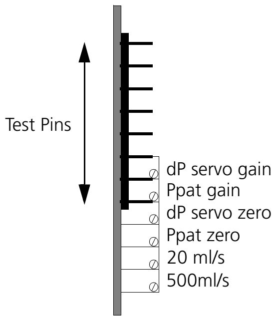


Figure 9-13. **Identification of the potentiometers on the inspiratory (servo) valve board**

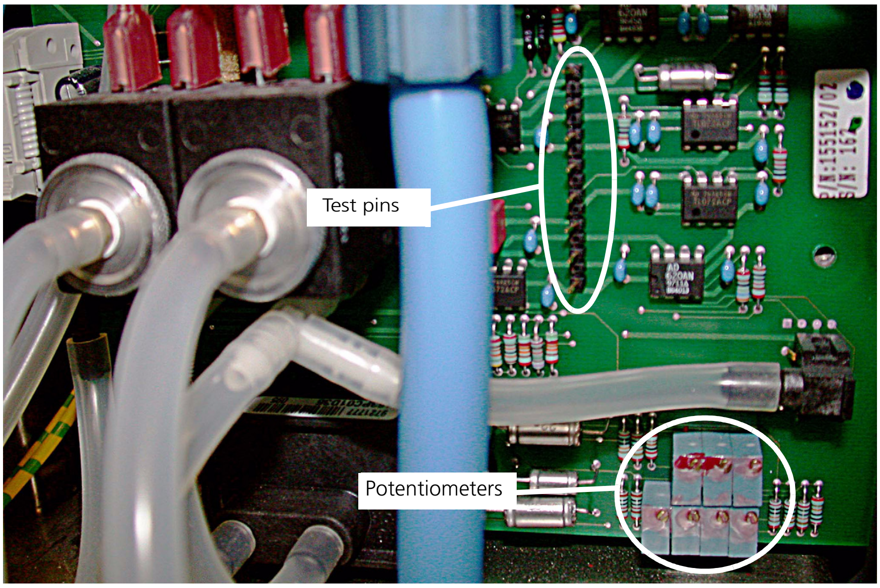


Figure 9-14. **Location of the potentiometers and test pins on the sensor board**

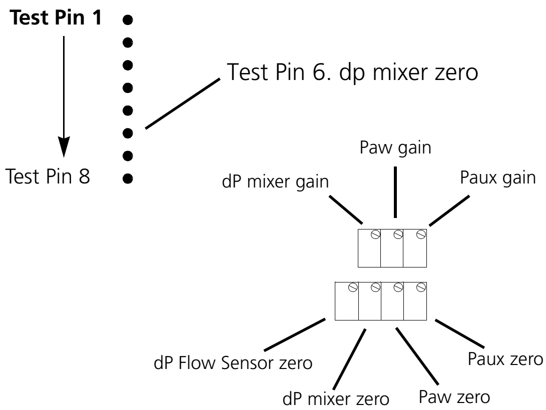


Figure 9-15. **Identification of the potentiometers and test pins on the sensor board**

4. Activate **`TSW 8: Zero and Fullscale`**. You see a display similar to the following:

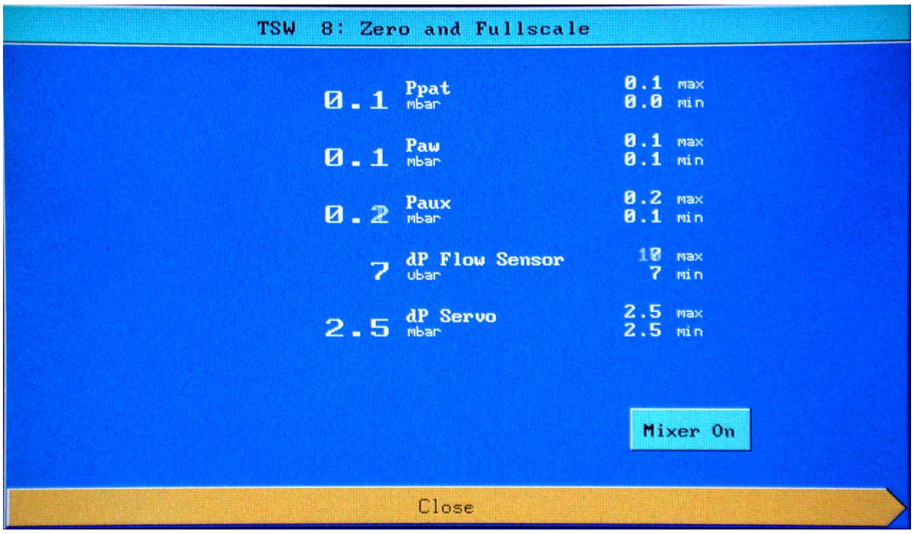


Figure 9-16. The `Zero and Fullscale` screen

TSW 8.3 Performing the Ppat, Paw, Paux, and dP Servo zero calibrations

Field	Function	Action
`Ppat`	Displays patient pressure: a measurement of the pressure in the patient breathing circuit as measured at the inspiratory valve.	Adjust potentiometer *Ppat zero* on the servo board (Figure 9-13 on page 9-29) until **`Ppat`** displays: **`0.0`** ±0.1
`Paw`	Displays patient airway pressure.	Adjust potentiometer *Paw zero* on the sensor board (Figure 9-15 on page 9-30) until **`Paw`** displays: **`0.0`** ±0.1
`Paux`	Displays auxiliary pressure.	Adjust potentiometer *Paux zero* on the sensor board (Figure 9-15 on page 9-30) until **`Paux`** displays: **`0.0`** ±0.1
`dP Servo`	Displays differential servo pressure: the pressure difference between the inflow and outflow of the inspiratory valve.	Adjust potentiometer *dP servo zero* on the servo board (Figure 9-13 on page 9-29) until **`dP Servo`** displays: **`0.0`** ±0.3

Troubleshooting the Ppat, Paw, Paux, and dP Servo zero calibrations

Problem Area	Symptom	Action
`Ppat` `Paw` `Paux` `dP Servo`	After correct adjustment, later moves out of range	Try replacing the following items in turn, repeating TSW 8.3 after each replacement: • The *sensor board*. (See Section 11.31.4, *Replacing the sensor board*, on page 11-195.) • The *servo board*. (See Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111.) **Note** If you replace an item and successfully repeat TSW 8.3, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.
	Cannot adjust to within range	

TSW 8.4 Performing the dP mixer zero calibration

1. Attach your volt meter to Test Pin 1 (ground) and Test Pin 6 on the sensor board. (Figure 9-14 and Figure 9-15 on page 9-30.)
2. Adjust potentiometer *dP mixer zero* (Figure 9-15 on page 9-30) until the volt meter reads **0 ±5** mV.

Troubleshooting the dP mixer zero calibration

Problem Area	Symptom	Action
dP mixer zero	Cannot adjust to within range.	• Ensure the tubing shown in Figure 9-11 on page 9-28 is disconnected. • Try replacing each of the following items in turn, repeating TSW 8.4 after each replacement: • Sensor board. (See Section 11.31.4, *Replacing the sensor board*, on page 11-195.) • Control board. (See Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.) **Note** If you replace an item and successfully repeat TSW 8.4, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 8.5 Performing the dP Flow Sensor zero calibration

1. Reconnect the tubing to the mixer.

2. Connect to the GALILEO:
   - Air
   - Oxygen
3. Connect a Flow Sensor (but without patient tubing) to the GALILEO. (Figure 9-17.)

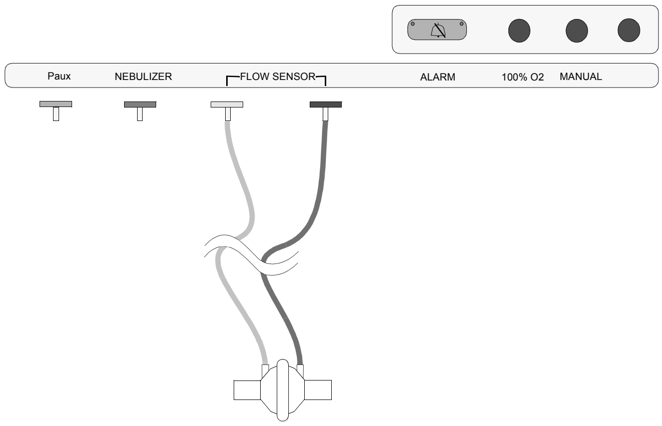


Figure 9-17. The Flow Sensor connected to the GALILEO

4. Activate **`Mixer On`**.
5. Make the following adjustment:

Field	Function	Action
`dP Flow Sensor`	Displays the pressure at the Flow Sensor's differential pressure sensor.	Adjust potentiometer *dP Flow Sensor zero* on the sensor board (Figure 9-15 on page 9-30) until **`dP Flow Sensor`** displays: **`0.0`** ±40.0

Troubleshooting the dP Flow Sensor zero calibration

Problem Area	Symptom	Action
`dP Flow Sensor`	Cannot adjust to within range.	• Ensure the Flow Sensor tubing is properly connected, both inside and outside the GALILEO, and try repeating TSW 8.5. • Try replacing the sensor board, and then repeating TSW 8.5. (Section 11.31.4, *Replacing the sensor board*, on page 11-195.) **Note** If you replace the sensor board and successfully repeat TSW 8.5, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 8.6 Performing the Ppat, Paw, and Paux full-scale calibrations

1. Build and connect the tubing setup shown in Figure 9-18.

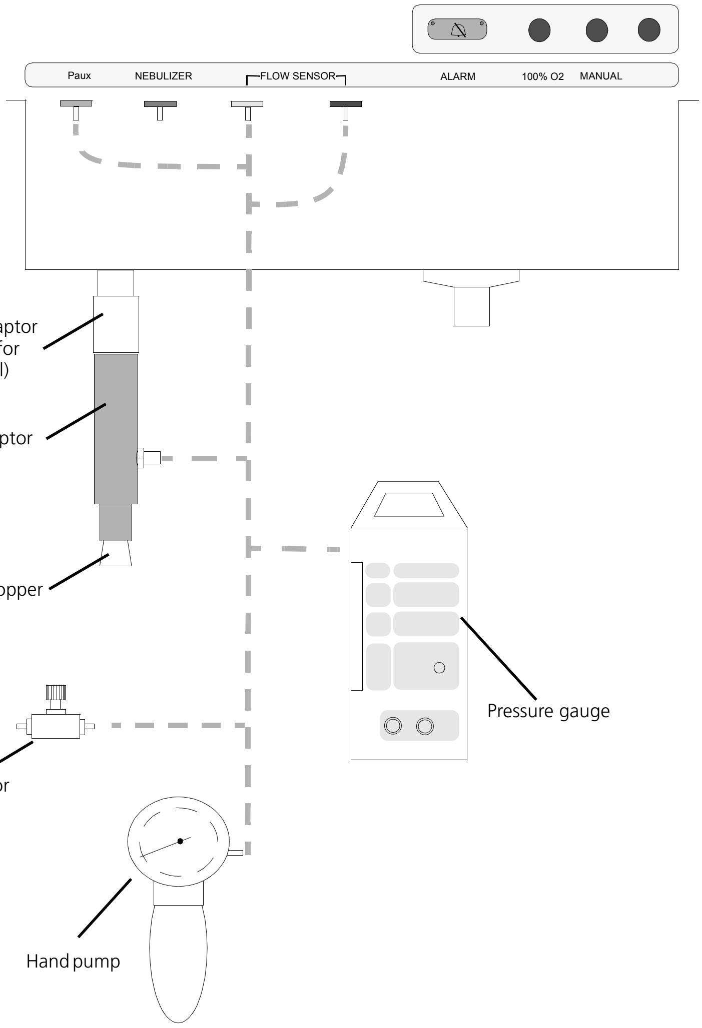


Figure 9-18. Setup for the Ppat, Paw, and Paux full-scale calibrations

2. Generate a pressure of approximately 80 mbar—as measured at the pressure gauge—by using the hand pump. (Sometimes you must gently press the pump to maintain the pressure. Sometimes you must use the flow restrictor so that you can continually release the air that enters the tubing from inspiratory (servo) valve leakage.)
3. Perform the following adjustments:

Field	Function	Action
`Ppat`	Displays patient pressure: a measurement of the pressure in the patient breathing circuit as measured at the inspiratory valve.	Adjust potentiometer *Ppat gain* on the servo board (Figure 9-13 on page 9-29) until `Ppat` displays the same value as the pressure gauge, working to a tolerance of ±5%. (Therefore, if the pressure gauge reads 80 mbar, `Ppat` can display 76 to 84 mbar.)

Field	Function	Action
`Paw`	Displays patient airway pressure	Adjust potentiometer *Paw gain* on the sensor board (Figure 9-15 on page 9-30), until **`Paw`** displays the same value as the pressure gauge, working to a tolerance of ±5%.
`Paux`	Displays auxiliary pressure	Adjust potentiometer *Paux gain* on the sensor board (Figure 9-15 on page 9-30), until **`Paux`** displays the same value as the pressure gauge, working to a tolerance of ±5%.

Troubleshooting the Ppat, Paw, and Paux full-scale calibrations

Problem Area	Symptom	Action
`Ppat` Paw Paux	Cannot adjust to within range.	Try replacing each of the following items in turn, repeating TSW 8.6 after each replacement: • The *inspiratory (servo) valve* and *servo board* module. *(See* Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111.*)* • Sensor board. (See Section 11.31.4, *Replacing the sensor board*, on page 11-195.) **Note** If you replace an item and successfully repeat TSW 8.6, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 8.7 Performing the dp Flow Sensor full-scale check

1. Build and connect the tubing setup shown in Figure 9-19. Use a probe suitable for measuring 10 mbar. The tubing is attached to the silver Flow Sensor connector.

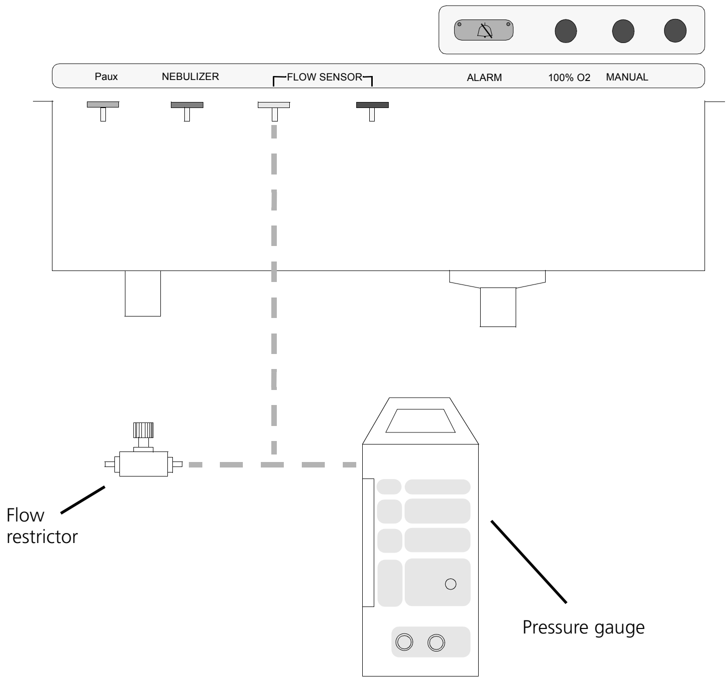


Figure 9-19. Setup for the Flow-Sensor full-scale check

2. Generate a pressure of approximately 2.5 mbar—as measured at the pressure gauge—by using the flow restrictor.
3. Perform the following check:

Parameter	Function	Check
`dP Flow Sensor`	Displays the Flow Sensor differential pressure.	`dP Flow Sensor` must read the same as the pressure gauge, to an accuracy of ±0.2 mbar. **Note** `dP Flow Sensor` is displayed in µbars, not mbars.

4. Remove the tubing from the silver (ventilator side) connector, and attach it to the blue (patient side) connector.
5. Generate a pressure of 2.5 mbar by using the flow restrictor.

6. Perform the following check:

Parameter	Function	Check
`dP Flow Sensor`	Displays the Flow Sensor differential pressure.	`dP Flow Sensor` must display a negative value the same as the positive value on the pressure gauge, to an accuracy of ±0.2 mbar. **Note** `dP Flow Sensor` is displayed in µbars, not mbars.

Troubleshooting the dP Flow Sensor full-scale check

Problem Area	Symptom	Action
`dP FLow Sensor`	Value is out of range.	• Ensure the Flow Sensor tubing is properly connected, both inside and outside the GALILEO, and try repeating TSW 8.7. • Try replacing the *sensor board* and then repeating TSW 8.7. (See Section 11.31.4, *Replacing the sensor board*, on page 11-195). **Note** If you replace an item and successfully repeat TSW 8.7, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 8.8 Performing the dP Servo full-scale calibration

1. Remove the tubing from the inspiratory valve. (Figure 9-20.)

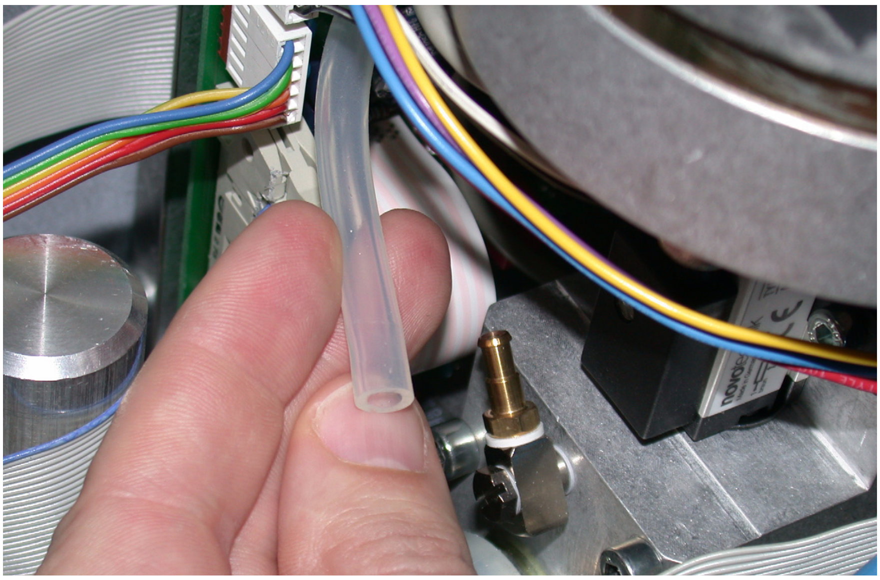


Figure 9-20. Tubing removed from the inspiratory valve

2. Build and connect the tubing setup shown in Figure 9-21 and Figure 9-22. On the pressure gauge use a probe suitable for reading approximately 500 mbar.
   A pressure of 200 to 500 mbar is generated by GALILEO.

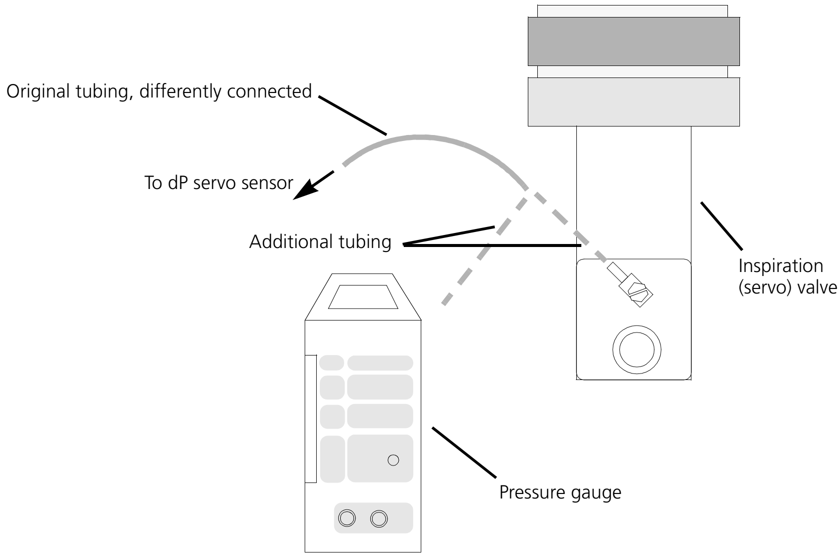


Figure 9-21. Setup for the dP Servo full-scale calibration

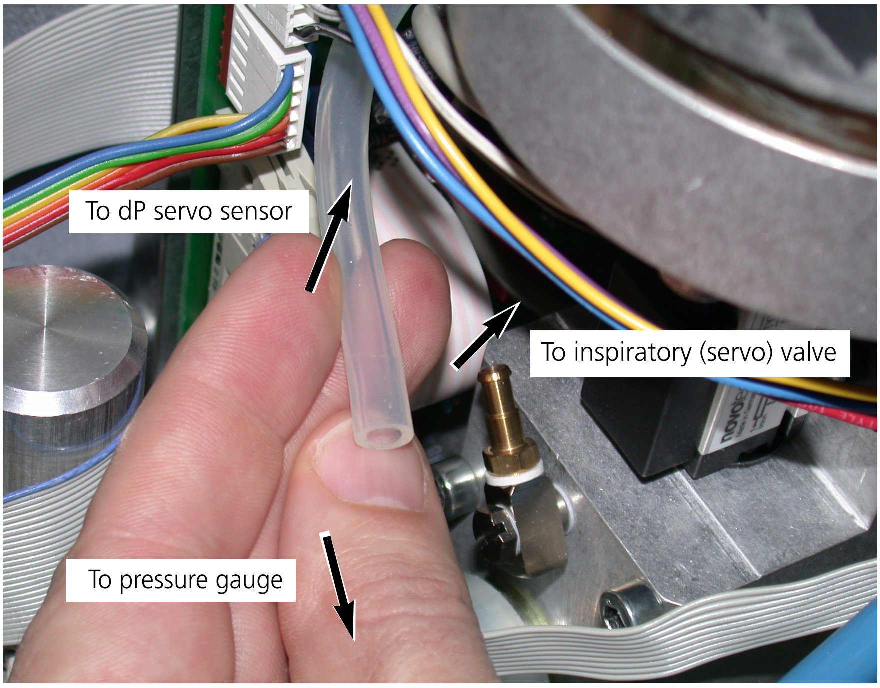


Figure 9-22. Tubing setup for the dP Servo full-scale calibration

3. Perform the following adjustment:

Parameter	Function	Action
`dP Servo`	Displays the pressure difference between the inflow and outflow of the inspiratory (servo) valve.	Adjust the *dP servo gain* potentiometer on the servo board (Figure 9-13 on page 9-29) until **`dP Servo`** displays the same value as the pressure gauge, working to a tolerance of ±1 mbar.

4. Replace the tubing on the inspiratory valve.

Troubleshooting the dP Servo full-scale calibration

Problem Area	Symptom	Action
`dP Servo`	Cannot adjust to within range	Try replacing the *inspiratory (servo) valve* and *servo board* module (Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111), and repeating TSW 8.8. **Note** If you replace an item and successfully repeat TSW 8.8, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 8.9 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`** (or the local language equivalent).

TSW 9: O2 Measurement

TSW 9.1 Overview

This test unit enables you to:

- Calibrate the *oxygen cell*
- Check the calibration of the oxygen cell
- Test the oxygen-cell solenoid valves

TSW 9.2 Background information

The oxygen cell is calibrated at 100% oxygen for greatest accuracy, and the linearity of the measurement is tested at 50% oxygen, 21% oxygen (pure air) and 100% oxygen, at the end of the calibration.

TSW 9.3 Preparation

1. Ensure that the oxygen cell is installed. If it is a new cell, and has been stored in a refrigerator, leave it for at least half an hour to reach room temperature.
2. Connect the air and oxygen.
3. Activate **`TSW 9: O2 Measurement`**. You see a display similar to the following:

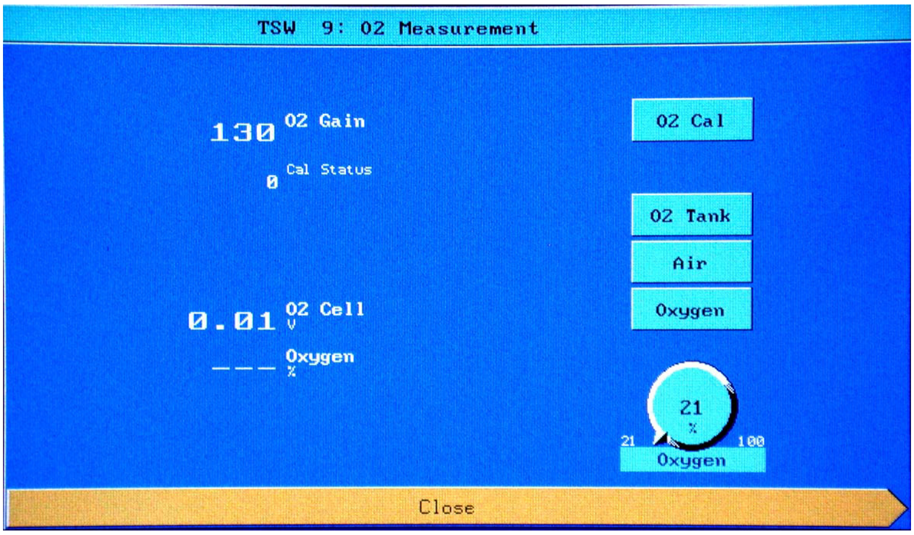


Figure 9-23. The `O2 Measurement` screen

TSW 9.4 Performing the oxygen cell calibration

Field or Button	Function	Action	Check
`O2 Cal` (button)	Enables calibration of the oxygen cell. When activated, 100% oxygen is sent to the oxygen cell, and the voltage of the cell is measured. After a minute, air is sent and the voltage measured again.	1. Activate the **`O2 Cal`** button. 2. Wait two minutes while **`O2 Cell Cal. in progress`** is displayed.	3. Screen must display **`O2 Cell is calibrated`** (or your local language equivalent).
`Cal Status`	Displays the status of the calibration process. The value **`1`** indicates that the process is running. The value **`0`** indicates that the process is complete. **Note** The value **`0`** does not necessarily indicate a successful calibration.		4. **`Cal Status`** must display **`0`**.

Troubleshooting the oxygen cell calibration

Problem Area	Symptom	Action
`O2 Cal` (button)	**`O2 cell cal. needed`** (or your local language equivalent) is displayed. The calibration was not successful.	• Ensure that oxygen is connected. • Try replacing the O2 cell, and repeating this test. If the test is successful, it is not necessary to repeat all test software units. Continue to TSW 9.5, *Performing the oxygen cell calibration checks* • If the cell will not calibrate, continue to TSW 9.5, *Performing the oxygen cell calibration checks*, where you can isolate the fault.

TSW 9.5 Performing the oxygen cell calibration checks

Field or Button	Function	Action	Check
`Oxygen` "knob" **Note** This field is displayed in the local language.	Enables you to select the concentration of oxygen delivered by the mixer to the tank. The tank is flushed until the required concentration is reached. **Note** This field is displayed in the local language.	1. Activate the `Oxygen` "knob". 2. Turn the "knob" quickly, until **50** is displayed (50% oxygen). 3. Deactivate the "knob".	
`O2 Tank` (button)	Enables you to send gas from the tank to the oxygen cell, thereby measuring the oxygen concentration in the tank set by the `Oxygen` "knob".	4. Activate the `O2 Tank` button.	5. Ensure `O2 Gain`, `O2 Cell` and `Oxygen` are in the ranges shown on Table 9-2 on page 9-43.
`Air` (button)	Enables you to send air to the oxygen cell, thereby measuring the concentration of oxygen in the air from the air inlet.	6. Activate the `Air` button.	7. Ensure `O2 Gain`, `O2 Cell` and `Oxygen` are in the ranges shown on Table 9-2 on page 9-43.
`Oxygen` (button)	Enables you to send pure oxygen to the oxygen cell, thereby measuring the oxygen concentration in the gas from the oxygen inlet.	8. Activate the `Oxygen` button.	9. Ensure `O2 Gain`, `O2 Cell`, and `Oxygen` are in the ranges shown on Table 9-2 on page 9-43.
`O2 Gain` (field)	Displays the gain applied by GALILEO to the voltage from the oxygen cell. A higher gain indicates an older cell.	None.	As detailed in the grey sections above, ensure the value is in the range shown on Table 9-2 on page 9-43.
`O2 Cell` (field)	Displays the voltage generated by the oxygen cell.	None.	As detailed in the grey sections above, ensure the value is in the range shown on Table 9-2 on page 9-43.
`Oxygen` (field)	Displays the concentration of oxygen being measured by the oxygen cell.	None.	As detailed in the grey sections above, ensure the value is in the range shown on Table 9-2 on page 9-43.
`Cal Status` (field)	Displays the status of the calibration process. The value **1** indicates that the process is running. The value **0** indicates that the process is complete. **Note** The value **0** does not necessarily indicate a successful calibration.	None.	None.

Button Activated	Field		
	`O2 Gain`	`O2 Cell`	`Oxygen`
`O2 Tank` (with 50% set on the `Oxygen` "knob")	`75` to `255`	`1.25` to `4.25`	`47` to `53`
`Air`	`75` to `255`	`0.5` to `1.7`	`19` to `23`
`Oxygen`	`75` to `255`	`2.5` to `8.5`	`98` to `100`

Table 9-2. **Values for TSW 9.5**

Troubleshooting the oxygen cell calibration checks

Problem Area	Symptom	Action
`O2 Gain` (field)	Value too high	• Ensure that the air and oxygen supplies are functioning properly. • Repeat the oxygen cell calibration. • If cell calibration is unsuccessful, replace the oxygen cell and start this unit again. (It is not necessary to perform all test units again.) • Check the mixer valves and wiring.
	Value too low	• Ensure that the air and oxygen supplies are functioning properly.
`O2 Cell` (field)	Value too high	• Ensure that the air and oxygen supplies are connected and functioning properly. • Repeat the oxygen cell calibration. • If cell calibration is unsuccessful, replace the oxygen cell and start this unit again. (It is not necessary to perform all test units again.) • Check the mixer valves and wiring.
	Value too low	The oxygen cell cannot create sufficient voltage because it is too old. Replace it.
`Oxygen` (field)	Value out of range with `O2 Tank` button pressed	• Ensure that the air and oxygen supplies are connected and functioning properly. • Repeat the oxygen cell calibration. • If cell calibration is unsuccessful, replace the oxygen cell and start this unit again. (It is not necessary to perform all test units again.) • Check the oxygen cell solenoid valves. • Check the mixer valves and wiring.
	Value out of range with `Air` button pressed	• Ensure that the air and oxygen supplies are connected and functioning properly. • Check the oxygen cell solenoid valves.
	Value out of range with `Oxygen` button pressed	• Ensure that the air and oxygen supplies are connected and functioning properly. • Ensure that the oxygen supplied is pure oxygen. • Check the oxygen cell solenoid valves.

TSW 9.6 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate `Close` (or the local language equivalent).

TSW 10: Mixer

TSW 10.1 Overview

This test unit enables you to check:

- Leakage from the *tank*
- Leakage from the *mixer*
- The functioning of the *mixer valves*
- The functioning of the *tank overpressure valve*

In addition, you calibrate the *mixer gain*, thereby setting the maximum pressure reached by the tank during the gas-inlet / gas-use cycle (although when flushed to create a new gas mixture, the tank reaches a higher pressure).

TSW 10.2 Preparation

1. Make sure that the oxygen cell, and the air and oxygen supplies remain in place.
2. Activate **`TSW 10: Mixer`**. You see a display similar to the following:

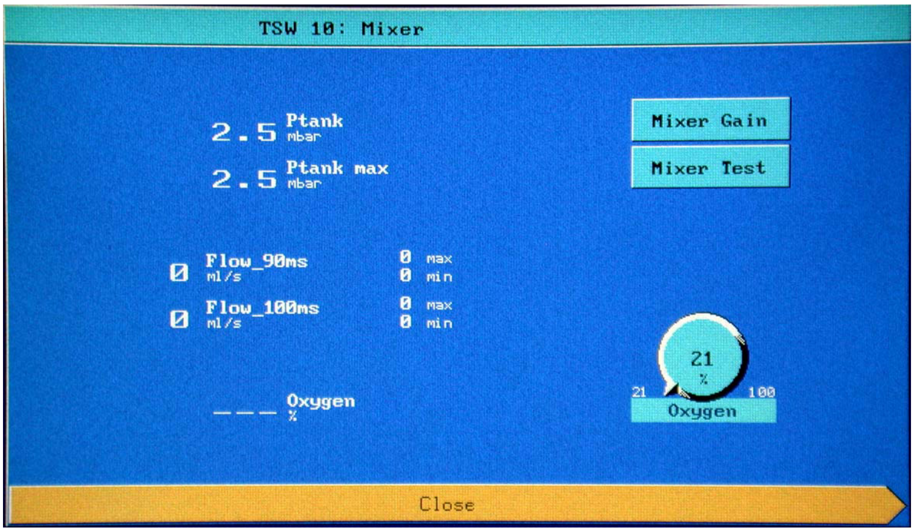


Figure 9-24. The `Mixer` screen

TSW 10.3 Performing the tank leakage check

This test checks for leaks both into, and out of, the tank.

Field	Function	Action	Check
`Ptank`	Displays the current tank pressure in millibars. During this check, the pressure decreases with time, because of tank gas is used for the rinse flow.	None.	Ensure that the time required for the tank to sink from 300 to 280 mbar is more than 8 seconds. **Note** You must perform this check before the tank pressure sinks below 300 mbar. If the tank pressure has already dropped below this limit, wait several minutes for the tank to repressurize itself.

Troubleshooting the tank leakage check

<table>
<tr><th>Problem Area</th><th>Symptom</th><th>Action</th></tr>
<tr><td rowspan="2"><code>Ptank</code></td><td>Tank pressure sinks too quickly. (There is a leak from the tank.)</td><td>• Check all connections to the tank:
  • All tubes, including the connection to the tank, and the connection to the other component.
  • The O-ring between the tank and the inspiratory (servo) valve. (See Section 11.22.6, Replacing the inspiratory valve / servo board assembly, on page 11-111, and particularly Figure 11-122, Inserting the new O-ring into its location, on page 11-115.)
• Try replacing each of the following items in turn, repeating TSW 10.3 after each replacement:
  • The inspiratory (servo) valve. (See Section 11.22.6, Replacing the inspiratory valve / servo board assembly, on page 11-111.)
  • The tank overpressure valve. (See Section 11.33.6, Replacing the sintered disk and tank overpressure relief valve, on page 11-210.)

Note
If you replace an item and successfully repeat TSW 10.3, you must then perform all test software units, starting with TSW 1: GMP Selftest, on page 9-3.</td></tr>
<tr><td>Tank pressure rises. (There is a leak from the mixer into the tank.)</td><td>• Try disconnecting the air supply at the rear of GALILEO. If the tank pressure continues to rise, replace the oxygen mixer inlet valve. (See Section 11.25.5, Replacing the mixer block or mixer valves, on page 11-144.) Repeat TSW 10.3.
• If necessary, do the same with the oxygen supply and air mixer valve. Repeat TSW 10.3.

Note
If you replace an inlet valve and successfully repeat TSW 10.3, you must then perform all test software units again, starting with TSW 1: GMP Selftest, on page 9-3.</td></tr>
</table>

TSW 10.4 Performing the mixer valves checks

Field	Function	Action	Check
`Flow_90ms`	Displays the combined leakage flow from both mixer valves. This value is measured in milliliters per second, 90 milliseconds after the valves close.	None.	The value displayed must be in the range: `0` to `300` (It is very common that the value 0 is displayed. This does not suggest that the test did not function correctly.)
`Flow_100ms`	As for `Flow_90ms`, but measured after 100ms.	None.	The value displayed must be in the range: `0` to `200` (It is very common that the value `0` is displayed. This does not suggest that the test did not function correctly.)

Troubleshooting the mixer valves check

Problem Area	Symptom	Action
`Flow_90ms` `Flow_100ms`	Value is out of range.	• Try disconnecting the air supply at the rear of GALILEO. If the tank pressure continues to rise, replace the oxygen mixer inlet valve. (See Section 11.25.5, *Replacing the mixer block or mixer valves*, on page 11-144.) Repeat TSW 10.4. • If necessary, do the same with the oxygen supply and air mixer valve. Repeat TSW 10.4. **Note** If you replace a valve and successfully repeat TSW 10.4, you must then perform all test software units again, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 10.5 Performing the mixer gain calibration

Field or Button	Function	Action	Check
Mixer Gain (button)	Enables you to set the maximum pressure that can occur in the tank during the gas-inlet / gas-use cycle. (Higher pressures are reached when the tank is flushed to create a new gas mixture.) This operation calibrates the mixer in relation to the tank pressure currently measured by the pressure sensors on the servo board (which have already been calibrated).	1. Activate **Mixer Gain**. 2. Adjust potentiometer *dP mixer gain* on the sensor board (Figure 9-15 on page 9-30) until **Ptank max** displays **330** to **350** mbar. **Note** You must start with a pressure higher than 340 mbar, and adjust downwards to compensate for hysteresis in the tank.	
Ptank max (field)	Displays the maximum pressure setting for the tank. Pressure in the tank should not be able to rise above this value in normal (non-test) operation.		3. The value displayed must be in the range **330** to **350** after calibration.

Troubleshooting the mixer gain calibration

Problem Area	Symptom	Action
Ptank max	Cannot adjust into range.	Try replacing each of the following items in turn, repeating TSW 10.5 after each replacement: • Sintered disk (if pressure displayed is too high). (Section 11.33.6, *Replacing the sintered disk and tank overpressure relief valve*, on page 11-210.) • Tank overpressure valve. (Section 11.33.6, *Replacing the sintered disk and tank overpressure relief valve*, on page 11-210.) • Sensor board. (Section 11.31.4, *Replacing the sensor board*, on page 11-195.) **Note** If you replace an item and successfully repeat TSW 10.5, you must then perform all test software units again, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 10.6 Performing the tank overpressure-valve check

Field or Button	Function	Action	Check
`Mixer Test` (button)	Enables you to check the safe operation of the tank's overpressure valve.	1. Activate the **`Mixer Test`** button.	
`Oxygen` "knob" **Note** This field is displayed in the local language.	Enables you to select the concentration of oxygen delivered by the mixer to the tank. The tank is flushed until the required concentration is reached.	2. Activate the **`Oxygen`** "knob" and turn it to display **`50`** (50% oxygen). The tank is flushed with oxygen, and is pressurized until the tank overpressure valve opens.	
`Ptank` (field)	Displays the current tank pressure in millibars.		3. The value displayed must be less than **`500`**.

Troubleshooting the tank overpressure-valve check

Problem Area	Symptom	Action
`Ptank` (field)	Displays more than **`500`**.	• Remove the sintered sound absorber disc from the tank overpressure valve, to check whether it is blocking the flow. Replace if necessary. (See Section 11.33.6, *Replacing the sintered disk and tank overpressure relief valve*, on page 11-210.) • Replace the tank overpressure valve. (See Section 11.33.6, *Replacing the sintered disk and tank overpressure relief valve*, on page 11-210.)

TSW 10.7 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`** (or the local language equivalent).

TSW 11: Auto Zero Valves

TSW 11.1 Overview

This test unit enables you to check:

- The *Flow Sensor autozero valves*
- The *autorinse assembly*

TSW 11.2 Background information

In normal use, the Flow Sensor autozero valves stay closed for most of the time. This keeps both the small pneumatic connectors to the Flow Sensor airtight, and allows the *Flow Sensor differential-pressure sensor* inside GALILEO to compare pressures on either side of the Flow Sensor.

However, at calculated intervals during normal use (the exact times depend upon many factors) the two autozero valves open together, thereby bringing both sides of the Flow Sensor differential-pressure sensor to the same (ambient) pressure. This enables GALILEO to automatically perform a zero calibration of the sensor.

During this test software unit, the autozero valves continuously open for five seconds and then close for five seconds. When open, the pressure at the sensor drops to approximately zero. When the valves close, and ***when one Flow Sensor connector is blocked with a finger***, the pressure on one side of the sensor builds to a value determined by the rinse flow.

Pressure on one side of the differential-pressure sensor is measured as positive (with one Flow Sensor connector blocked), while pressure on the other side is measured as negative (with the other Flow

Sensor connector blocked). Figure 9-25 shows a very simplified view of the Flow Sensor connections inside GALILEO during this test.

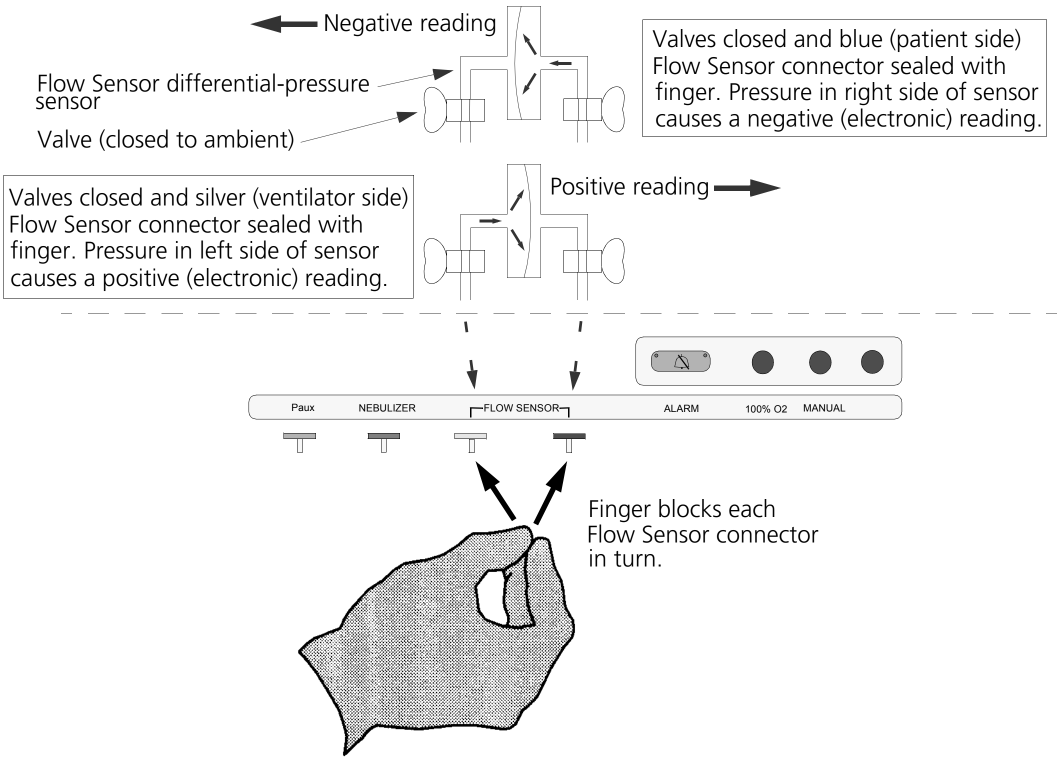


Figure 9-25. **Positive and negative test readings at the Flow Sensor differential-pressure sensor**

TSW 11.3 Preparation

Activate **`TSW 11: Auto Zero Valves`**. The autozero valves begin a sequence of opening for five seconds, and then closing for five seconds, and you see a display similar to the following:

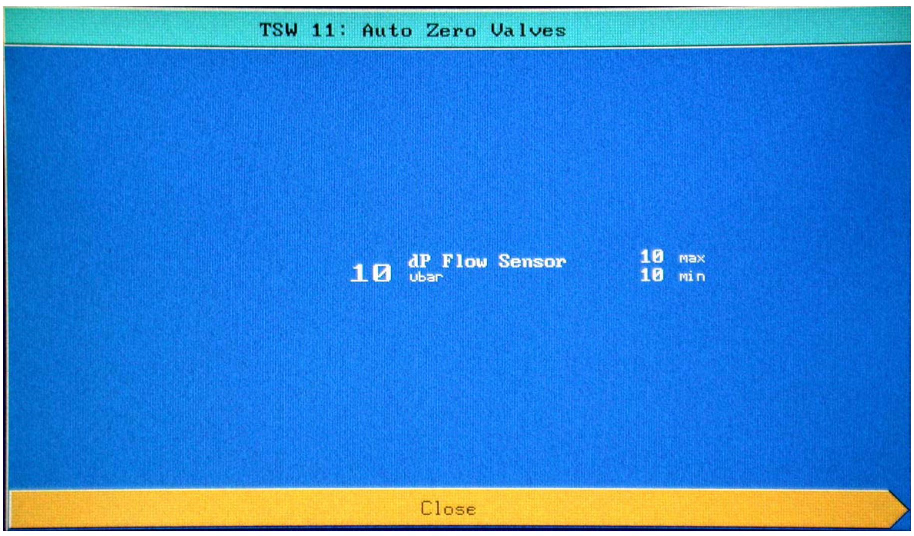


Figure 9-26. **The `Auto Zero Valves` screen**

TSW 11.4 Performing the Flow-Sensor autozero-valve check

Field	Function	Action	Check
`dP Flow Sensor`	Displays the pressure at the Flow Sensor's differential pressure sensor. During this check, the pressure changes from approximately zero (when both sides of the Flow Sensor differential-pressure sensor are open to ambient pressure) to approximately 5000 (when one side of the Flow Sensor differential-pressure sensor is sealed, enabling the rinse flow to build pressure in that side).	**Note** It is permissible for intermediate values to be briefly displayed while GALILEO moves between the lowest and highest readings.	
		1. Seal the silver Flow Sensor connector with a finger. (Figure 9-27.)	2. Ensure that **`dP Flow Sensor`** alternates every five seconds between the following: • A value in the range **`-40`** to **`40`** • A value in the range **`5040`** to **`5200`**
		3. Seal the blue (patient side) Flow Sensor connector with a finger.	4. Ensure that **`dP Flow Sensor`** alternates every five seconds between the following: • A value in the range **`-40`** to **`40`** • A value in the range **`-5040`** to **`-5200`**

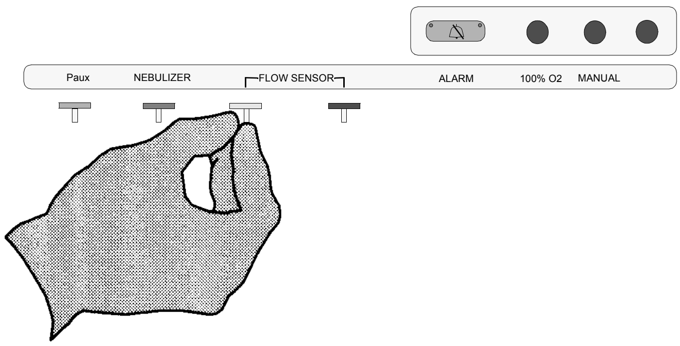


Figure 9-27. Sealing the silver Flow Sensor connector

Troubleshooting the Flow-Sensor autozero-valve check

Problem Area	Symptom	Action
`dP Flow Sensor`	Value out of range.	• Ensure that the autozero valves on the sensor board are properly connected without leaks. (See Section 2.3, *Components performing principle pressure and flow measurements*.) • If there are no leaks, try replacing the sensor board and repeating TSW 11.4. (See Section 11.31.4, *Replacing the sensor board*, on page 11-195.) **Note** If you replace the sensor board and successfully repeat TSW 11.4, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 11.5 Performing the rinse flow check

Ensure that the rinse flows through both of the small pneumatic connections to the Flow Sensor are equal. To do this:

1. Prepare two tubes of exactly equal length, approximately 15 cm long.
2. Attach one tube to the silver (ventilator side) Flow Sensor connector, and one to the blue (patient side) connector.
3. Place the ends of the tubes in a glass of water, as shown in Figure 9-28.

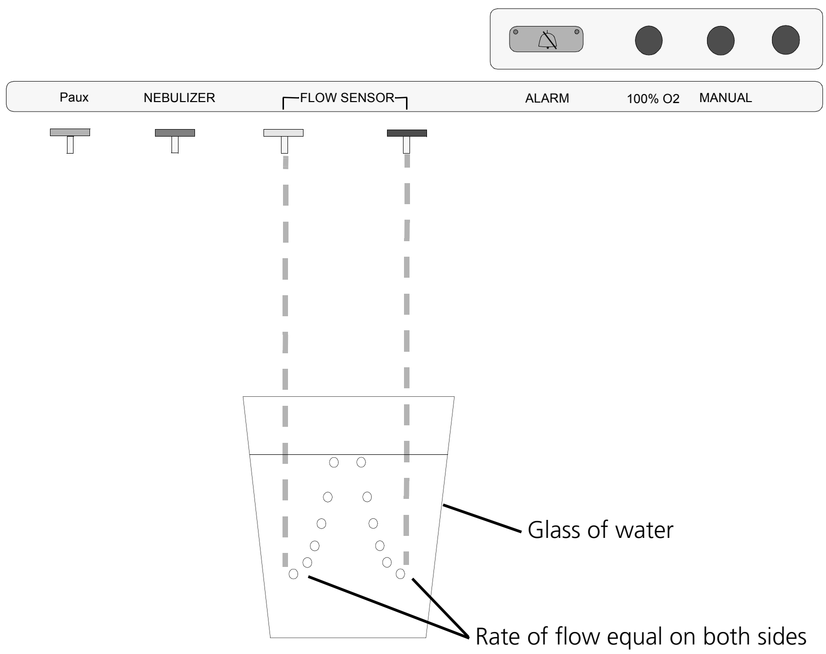


Figure 9-28. Checking the rinse flow rates

4. Ensure that the number of air bubbles appears almost exactly equal on both sides.

Troubleshooting the rinse flow check

Symptom	Action
Rate of flow is not equal on both sides.	• Ensure there is no air leak in the tubes or at the connectors.
There are no bubbles.	• Replace the Flow-Sensor rinse-flow sintered disk “pills” (flow restrictors). (See Section 11.32.6, *Managing tank connections and “pill” flow restrictors*, on page 11-201.)

TSW 11.6 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`** (or the local language equivalent).

TSW 12: Safety Valve Block

TSW 12.1 Overview

This test unit enables you to check:

- That the *inspiratory (servo) valve* is airtight
- That the *safety valve block* is airtight
- The pressure at which the *patient overpressure valve* opens

TSW 12.2 Preparation

Activate **`TSW 12: Safety Valve Block`**. You see a display similar to the following:

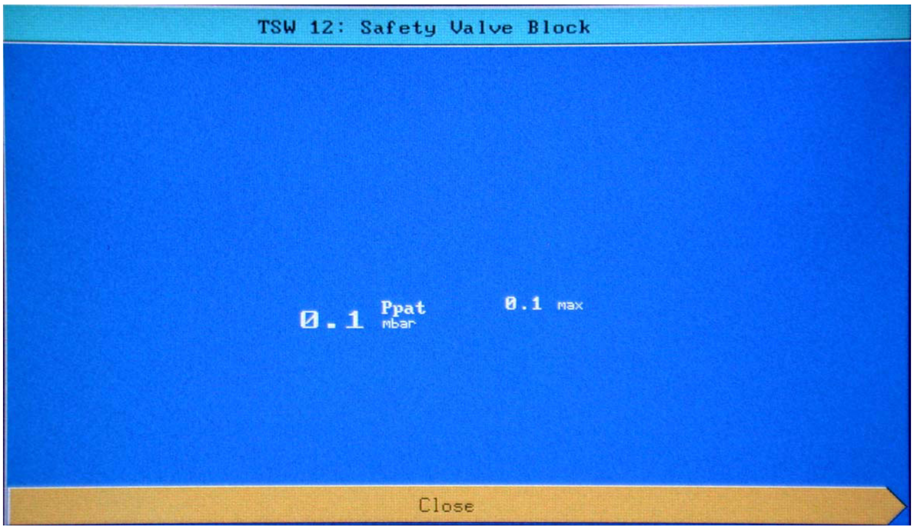


Figure 9-29. The `Safety Valve Block` screen

TSW 12.3 Performing the inspiratory-valve airtightness check

1. Connect the 20 ml/s capillary tube and the pressure gauge as shown in Figure 9-30 below.

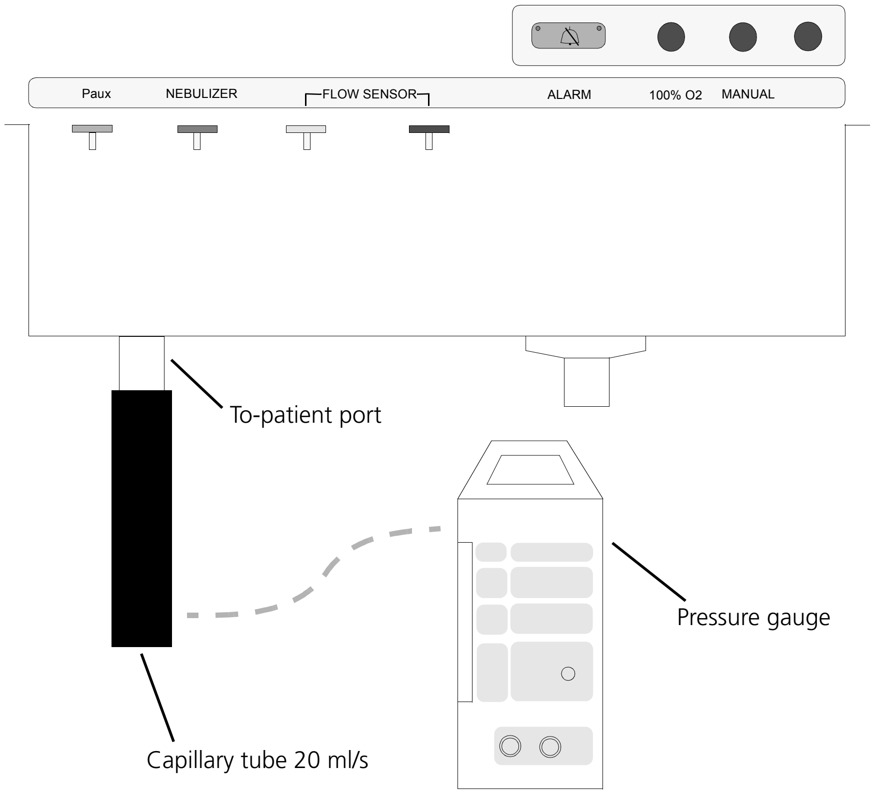


Figure 9-30. Setup for the inspiratory-valve airtightness check

2. Check that the pressure at the pressure gauge is as shown in Table 9-3.

Note
Leakage ranges depend upon the kind of inspiratory valve you have—old or new. You can read the part number on the label on top of the inspiratory valve.

Inspiratory valve PN 155161 (Old type)	Inspiratory valve PN 155491 (New type)
0 to 10 mbar	0 to 4 mbar

Table 9-3. Inspiratory-valve leakage values

Troubleshooting the inspiratory-valve airtightness check

Symptom	Action
Pressure gauge reads higher than 10 mbar with old type valve, or higher than 4 mbar with new type. (Leakage is too high.)	Try replacing the *inspiratory (servo) valve* and *servo board* module (see Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111) and repeating TSW 12.3. **Note** If you replace the servo module and successfully repeat TSW 12.3, you must then perform all test software units again, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 12.4 Performing the safety-valve-block airtightness check

1. Connect the tubing system as shown on Figure 9-31.

CAUTION

The connection between the hand pump and the GALILEO must have a volume of approximately 345 ml. The easiest way to achieve this is to connect the pump using a tube with a length of 110 cm and a diameter of 22 mm.

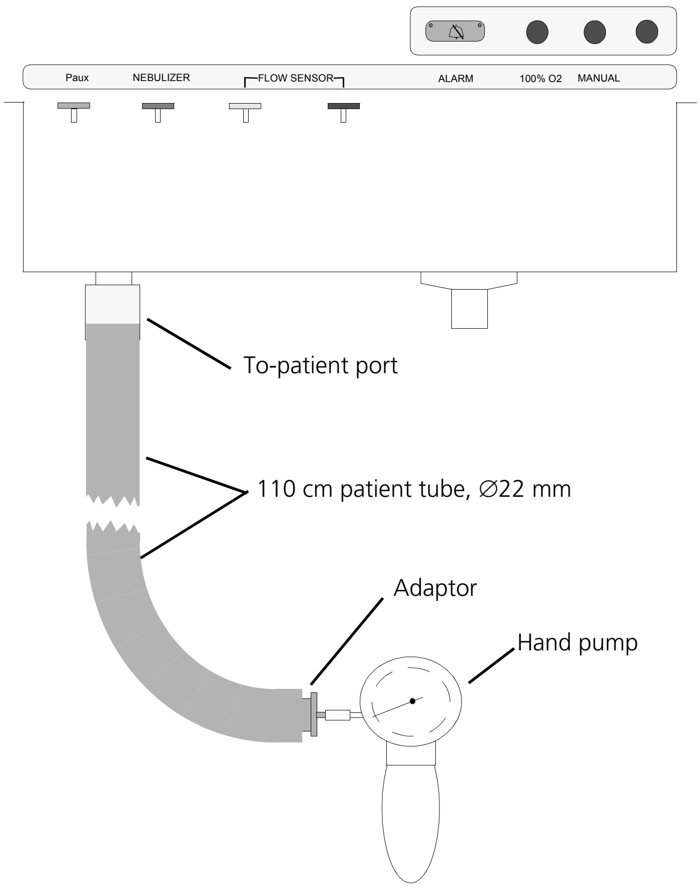


Figure 9-31. **Setup for the safety-valve-block airtightness and patient overpressure-valve checks**

2. Generate a pressure of 90 mbar with the hand pump.
3. Check that the time required for the pressure in the patient tube to decrease from 90 to 43 mbar is more than 10 seconds.

Troubleshooting the safety-valve-block airtightness check

Symptom	Action
Pressure in patient tube decreases too fast.	• Ensure there is no air leak in the external patient tubing or at the connectors. • Ensure there is no air leak in the tubes connecting to the *safety valve block*. (See Section 4.3, *Ambient valve and patient overpressure valve*, on page 4-3.) • Try replacing the *safety valve block* and repeating TSW 12.4. (See Section 11.7.5, *Maintaining and replacing the ambient and patient overpressure valves*, on page 11-22.) **Note** If you replace the safety valve block, you must repeat all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.
Pressure in patient tube increases.	If there is an increase in pressure: • Reduce the pressure to 70 mbar. • Check that the time for the pressure in the patient tube to increase from 50 to 97 mbar is more than 10 seconds. • If the time is less than 10 seconds, replace the inspiratory valve. **Note** If you replace the inspiratory valve, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 12.5 Performing the patient overpressure-valve check

1. Using the setup for the safety-valve-block airtightness check (Figure 9-31 on page 9-58), simulate an overpressure by continuously pumping the hand pump.
2. The overpressure valve must open and the pressure must drop (this can be clearly observed) when the pump reaches a pressure of between 104 and 116 mbar.

Troubleshooting the patient overpressure-valve check

Symptom	Action
Overpressure valve does not open in correct pressure range.	Replace the patient overpressure valve (see Section 11.7.5, *Maintaining and replacing the ambient and patient overpressure valves*, on page 11-22) and repeat TSW 12.5. **Note** If you replace the overpressure valve, and successfully repeat TSW 12.5, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 12.6 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`** (or the local language equivalent).

TSW 13: Ambient Valve

TSW 13.1 Overview

This test unit enables you check the *ambient valve*.

TSW 13.2 Preparation

1. Connect the patient tubing and your own personal bacteria filter as shown in Figure 9-32 below.

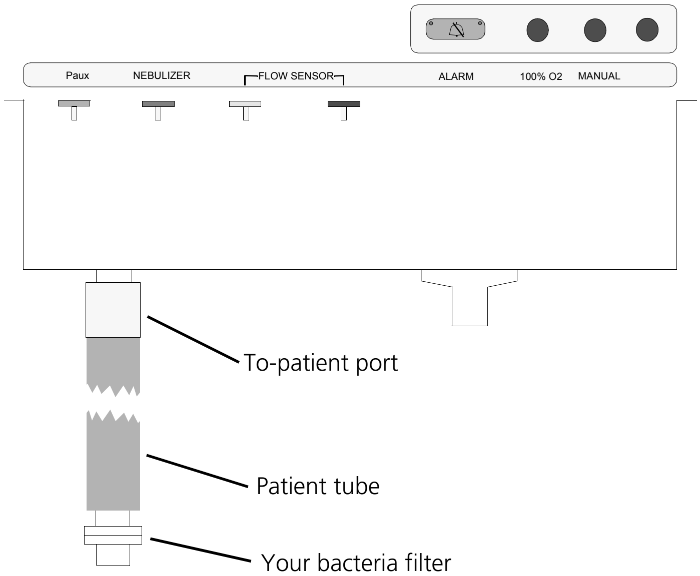


Figure 9-32. Tubing setup for the ambient valve check

2. Activate **`TSW 13: Ambient Valve`**. You see a display similar to the following:

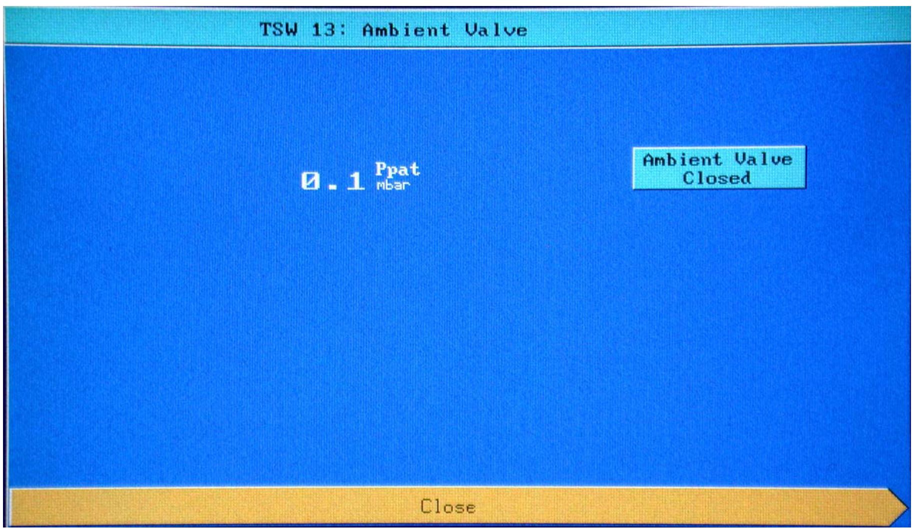


Figure 9-33. The `Ambient Valve` screen

TSW 13.3 Performing the ambient valve check

Buttons and Fields	Function	Action	Check
`Ppat` (field)	Displays patient pressure: a measurement of the pressure in the patient breathing circuit as measured at the inspiratory valve.	1. Inhale through the bacteria filter.	2. Ensure that it is possible to inhale, and that `Ppat` is in the range `0` to `-20` mbar.
		3. Try to exhale through the bacteria filter.	4. Ensure that it is not possible to exhale.
`Ambient Valve Closed` (button)	Opens and closes the ambient valve.	1. Activate `Ambient Valve Closed`.	
		2. Try to inhale and exhale through the bacteria filter.	3. Ensure that the ambient valve remains closed: you cannot inhale through the patient tubing.
		4. Deactivate `Ambient Valve Closed`.	
		5. Inhale through the bacteria filter.	6. Ensure that the ambient valve remains open: you can inhale through the patient tubing.

Troubleshooting the ambient valve check

Problem Area	Symptom	Action
`Ppat` `Ambient Valve Closed` (button)	Test fails.	• Ensure that all cables to the *safety valve block* and *control board* are correctly in place. • Try replacing each of the following items in turn, repeating TSW 13.3 after each replacement: • Solenoid. (See Section 11.7.5.1, *Replacing the ambient valve solenoid coil*, on page 11-22.) • Safety valve block. (See Section 11.7.5.2, *Replacing the safety valve block*, on page 11-24.) • The *connector board. (See* Section 11.10.6, *Replacing the connector board*, on page 11-40.) **Note** If you replace an item and successfully repeat TSW 13.3, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 13.4 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate `Close` (or the local language equivalent).

TSW 14: Servo and Flow Sensor

TSW 14.1 Overview

This test unit enables you to check and, if necessary, to calibrate the delivery of air from the *inspiratory (servo) valve*, and to calibrate the *Flow Sensor*.

Note
This test calibrates the *Flow Sensor differential-pressure sensor* inside GALILEO, for the *Flow Sensor* currently fitted in the patient breathing circuit.

TSW 14.2 Background information

For this test unit you require a 20 ml/s capillary tube, and a 500 ml/s orifice tube. Each of these tubes is marked with two values:

- The nominal flow rate (20 or 500 ml/s)
- The pressure at which that flow rate is achieved (typically in the region of 50 to 70 mbar)

Note
You must compensate the readings you take with the 500 ml/s orifice tube, in accordance with Table 9-4.

TSW 14.3 Preparation

1. Connect the 20 ml/s capillary tube and the pressure gauge as shown in Figure 9-34.

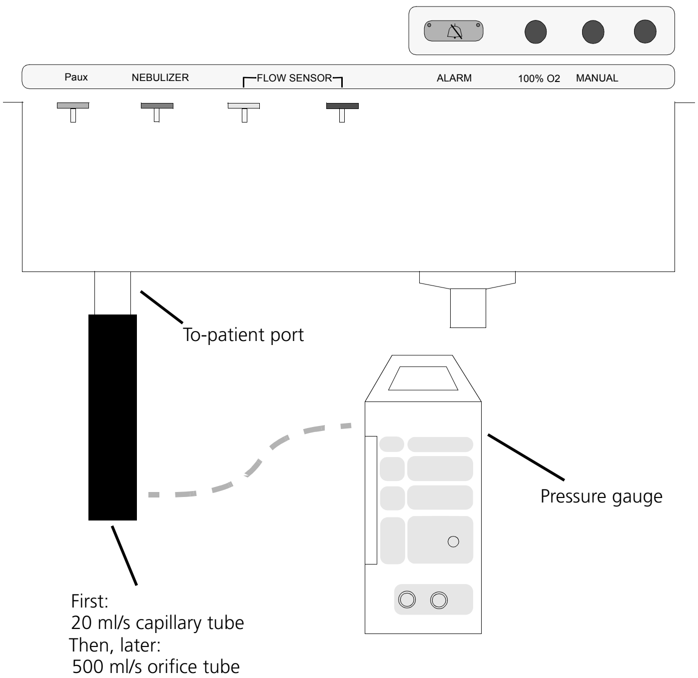


Figure 9-34. Setup for the inspiratory-valve air-delivery check

2. Activate **`TSW 14: Servo and Flow Sensor`**. You see a display similar to the following:

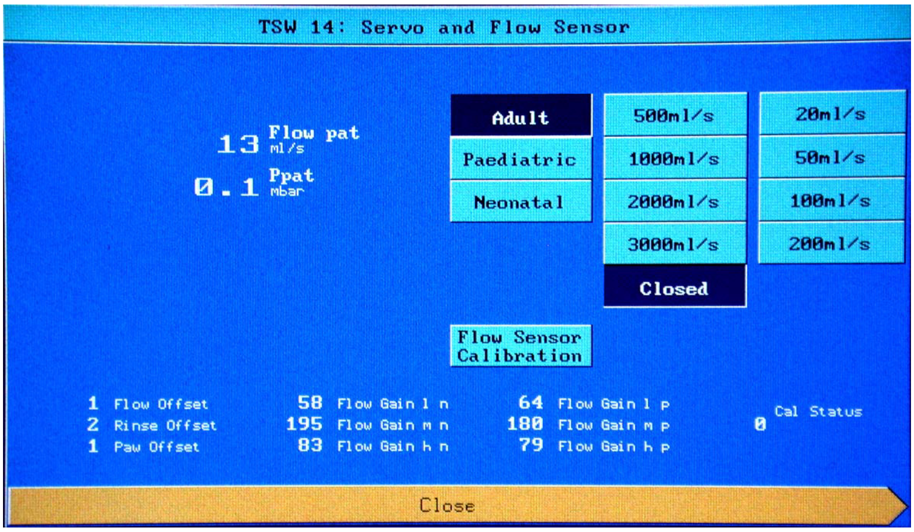


Figure 9-35. The `Servo and Flow Sensor` screen

TSW 14.4 Performing the inspiratory-valve air-delivery check

Button	Function	Action	Check
Adult	Prepares the GALILEO for an adult breathing circuit.	1. Activate **`Adult`**.	
`20ml/s`	Creates an airflow at the to-patient port of 20 milliliters per second.	2. Ensure the 20 ml/s capillary tube is connected, as shown in Figure 9-34 on page 9-63. 3. Activate **`20ml/s`**. **Note** No altitude correction is required for the 20 ml/s capillary tube.	4. The pressure gauge must read the pressure marked on the capillary tube ±3 mbar.
`500ml/s`	Creates an airflow at the to-patient port of 500 milliliters per second.	1. Attach the 500 ml/s orifice tube, as shown in Figure 9-34 on page 9-63. 2. Activate **`500ml/s`**. **Note** The 500 ml/s orifice tube was calibrated in Switzerland at 660 meters above mean sea level. If you are not at this altitude, you must apply a correction value according to Table 9-4 on page 9-65. For instance, if you are at 100 meters, you must add 3.6 mbars to the value shown on the pressure gauge.	3. The pressure gauge must read the pressure marked on the orifice tube ±2 mbar.

Altitude	0	50	100	150	200	250	300	350	400	450	500	550	600	650	660
Correction	+4.3	+4.0	+3.6	+3.3	+3.0	+2.7	+2.3	+2.0	+1.7	+1.4	+1.0	+0.7	+0.4	+0.1	0
Altitude	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100
Correction	-0.2	-0.9	1.5	-2.1	-2.7	-3.2	-3.8	-4.4	-5.0	-5.5	-6.1	-6.7	-7.2	-7.8	-8.4

Table 9-4. Altitude correction values for 500 ml/s orifice tube

Troubleshooting the inspiratory-valve air-delivery check

Problem Area	Symptom	Action
`20ml/s` (button) `500ml/s` (button)	Pressure gauge is out of range during check.	Calibrate the inspiratory valve. To do this: 1. Attach the 20 ml/s capillary tube and the pressure gauge. 2. Activate **`20ml/s`**. 3. Adjust potentiometer 20 ml/s on the servo board until the pressure is within range. (See Figure 9-12 and Figure 9-13 on page 9-29.) 4. Attach the 500 ml/s orifice tube and the pressure gauge. 5. Activate **`500ml/s`**. 6. Adjust potentiometer 500 ml/s on the servo board. (See Figure 9-12 and Figure 9-13 on page 9-29, and Table 9-4 on page 9-65.) 7. Repeat steps (1) to (6) until both readings are in range. **Note** The adjustment of one potentiometer affects the adjustment of the other. For this reason you must repeat the adjustments as often as required until both pressure readings are in range.
	Calibration does not bring pressure gauge into range.	Replace the inspiratory valve (Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111) and repeat TSW 14.4. **Note** If you replace the inspiratory valve module and successfully repeat TSW 14.4, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 14.5 Performing the Flow Sensor calibration

1. Connect a patient breathing circuit with a Flow Sensor but without a test lung. (The *GALILEO Intensive Care Ventilator Operator's Manual* has a diagram showing a suitable setup.)

2. Perform the following actions and checks:

Buttons and Fields	Function	Action	Check
`Adult`	Prepares the GALILEO for an adult breathing circuit and Flow Sensor.	**Note** The **`Adult`**, **`Paediatric`** and **`Neonatal`** buttons are not included in some older models. If you do not have these buttons, make sure that the type of breathing circuit you are using is the same as the type set for your ventilator. (You set this in operating mode.) Activate **`Adult`** if you are using an adult breathing circuit and Flow Sensor.	None.
`Paediatric`	Prepares the GALILEO for a pediatric breathing circuit and Flow Sensor.	Activate **`Paediatric`** if you are using an adult breathing circuit and Flow Sensor.	None.
`Neonatal`	Prepares the GALILEO for an infant breathing circuit and Flow Sensor.	Activate **`Neonatal`** if you are using an adult breathing circuit and Flow Sensor.	None.
`Flow Sensor Calibration` (button)	Starts the calibration of the Flow Sensor.	1. Activate **`Flow Sensor Calibration`**. 2. Follow the instructions on the screen, removing, turning, and replacing the Flow Sensor as instructed.	3. The screen must display **`Flow Sensor is calibrated`** (or your local language equivalent) at the end of calibration.
`Cal Status` (field)	Displays the status of the calibration process. All values except **`0`** indicate that the process is running. The value **`0`** indicates that the process is complete. **Note** The value **`0`** does not necessarily indicate a successful calibration.		4. **`Cal. status`** must display **`0`** at the end of calibration.

Troubleshooting the Flow Sensor calibration

Problem Area	Symptom	Action
Calibration fails	The message **`Flow Sensor is calibrated`** (or your local language equivalent) is not displayed at the same time that **`Cal Status`** displays **`0`**.	• Repeat the calibration—it is possible you made a mistake in handling or turning the Flow Sensor. • Ensure that you are using a breathing circuit and Flow Sensor of the correct type for the button you activated: **`Adult`**, **`Paediatric`** or **`Neonatal`**. • Check all external tubing for leaks. • Try replacing each of the following items in turn, repeating TSW 14.5 after each replacement: • The Flow Sensor. • The *inspiratory (servo) valve* module. (See Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111.) • The *sensor board*. (See Section 11.31.4, *Replacing the sensor board*, on page 11-195.) **Note** If you replace the sensor board and successfully repeat TSW 14.5, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 14.6 Performing the inspiratory-valve linearity check

1. Leave the patient tubing in place.

2. Perform the following actions and checks:

Buttons and Fields	Function	Action	Check
20ml/s **50ml/s** **100ml/s** **200ml/s** **500ml/s** **1000ml/s** Closed	Create an airflow at the to-patient port of 20, 50, 100... milliliters per second.	1. Activate 20ml/s. 2. Make sure that **Flow pat** is in the range shown on Table 9-5 on page 9-68. 3. Make sure that **Ppat** is in the range shown on Table 9-5 on page 9-68. 4. Repeat procedure for other buttons. **Note** Do not use the **2000ml/s** and **3000ml/s** buttons. It is only possible to attain a peak (not a constant) flow with these buttons.	
Flow pat (field)	Displays the flow to the patient in milliliters per second, as measured at the inspiratory valve.		As detailed in the grey section above, **Flow pat** values must always be in the range shown on Table 9-5 on page 9-68.
Ppat (field)	Displays patient pressure: a measurement of the pressure in the patient breathing circuit as measured at the inspiratory valve.		As detailed in the grey section above, **Ppat** values must always be in the range shown on Table 9-5 on page 9-68.

Buttons	Flow pat	Ppat
20ml/s	0 to 40	0 to 5
50ml/s	30 to 70	0 to 5
100ml/s	80 to 120	0 to 5
200ml/s	160 to 240	0 to 5
500ml/s	425 to 575	0 to 5
1000ml/s	850 to 1150	0 to 10
Closed	0 to 5	0 to 5

Table 9-5. Flow pat and Ppat values

Troubleshooting the inspiratory-valve check

Problem Area	Symptom	Action
`Flow pat` `Ppat`	One or more values are out of range.	Try replacing each of the following items in turn, repeating TSW 14.6 after each replacement: • *Flow Sensor* • The *inspiratory (servo) valve* and *servo board* module. (See Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111.) • The *sensor board*. (See Section 11.31.4, *Replacing the sensor board*, on page 11-195.) **Note** If you replace an item and successfully repeat TSW 14.6, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 14.7 Completing this unit

1. Do not remove the patient tubing.
2. Fill in the results of this test unit in your test report.
3. Activate **`Close`** (or the local language equivalent).

TSW 15: Expiration Valve

TSW 15.1 Overview

This test unit enables you to calibrate and check the *expiratory valve*.

TSW 15.2 Preparation

Activate **`TSW 15: Expiration Valve`**. You see a display similar to the following:

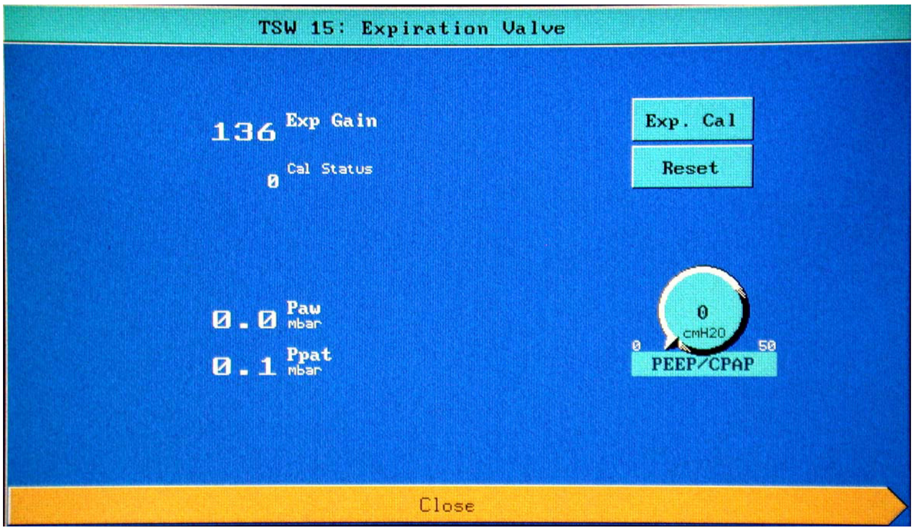


Figure 9-36. The `Expiration Valve` screen

TSW 15.3 Performing the expiratory valve calibration

1. Seal the open end of the Flow Sensor with a finger or thumb, so that the patient breathing circuit is completely enclosed. (Figure 9-37.)

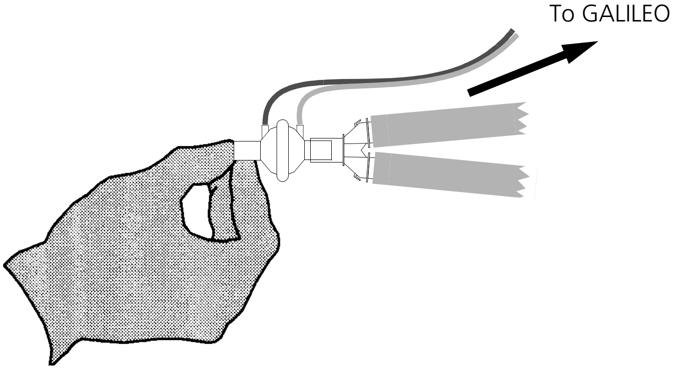


Figure 9-37. Sealing the Flow Sensor

2. Perform the following actions and checks:

Buttons and Fields	Function	Action	Check
Exp Gain (field)	Displays the gain applied to the analog signal controlling the *expiratory valve*. Calibrating the expiratory valve adjusts this value.	None.	None.
Reset (button)	Resets the value of **Exp Gain** to the factory setting of 128. (This makes later calibration easier, as calibration begins with the **Exp Gain** approximately correct.)	1. Activate **Reset**.	
Exp. Cal (button)	Starts the expiratory valve calibration procedure.	2. Activate **Exp. Cal**.	3. The screen must display **Exp. Valve Cal. ok** after a short time, at the end of the calibration procedure.
Cal Status (field)	Displays the status of the calibration process. The value **26** indicates that the process is running. The value **0** indicates that the process is complete. **Note** The value **0** does not necessarily indicate a successful calibration.		4. **Cal Status** must display **0** at the end of calibration.

Troubleshooting the expiratory valve calibration

Problem Area	Symptom	Action
Expiratory valve calibration	The message **`Exp. Valve Cal. ok`** is not displayed at the same time that **`Cal Status`** displays **`0`**.	• Check the cables going to the *expiratory valve*. • Check the cables going to the *connector board*. • Check the patient tubing system for leaks. • Check that air and oxygen supplies are connected properly. • Clean the expiratory valve plunger pin. • Try replacing each of the following items in turn, repeating TSW 15.3 after each replacement: • The *expiratory valve* cover. (See Section 11.13.6, *Replacing the expiratory valve positioning coil*, on page 11-67.) • The expiratory valve membrane. (See Section 11.13.6, *Replacing the expiratory valve positioning coil*, on page 11-67.) • The patient tubing system. • The *connector board*. *(See* Section 11.10.6, *Replacing the connector board*, on page 11-40.) • The *expiratory valve*. *(See* Section 11.13.6, *Replacing the expiratory valve positioning coil*, on page 11-67.) **Note** If you replace an item and successfully repeat TSW 15.3, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 15.4 Performing the expiratory valve linearity check

Note
Keep the seal on the Flow Sensor.

“Knob” and Fields	Function	Action	Check
`PEEP/CPAP` “knob”	Sets the lowest pressure that is ever permitted in the patient breathing circuit.	1. Activate the **`PEEP/CPAP`** “knob” with the control knob in the normal way. 2. Turn the **`PEEP/CPAP`** “knob” so that it displays **`0`**. Perform the **`Paw`** and **`Ppat`** checks for **`PEEP/CPAP`** “knob” **`0`**. (Table 9-6 on page 9-73.) 3. Repeat for values of **`5`**, **`10`** and **`30`**. (Table 9-6 on page 9-73.)	

"Knob" and Fields	Function	Action	Check
`Paw`	Displays the patient airway pressure.		As detailed in the grey section above, `Paw` must display the values shown on Table 9-6.
Ppat	Displays patient pressure: a measurement of the pressure in the patient breathing circuit as measured at the inspiratory valve.		As detailed in the grey section above, `Ppat` must display the values shown on Table 9-6.

`PEEP/CPAP` setting	`Paw`	`Ppat`
`0`	`0` to `1.5`	
`5`	`4.0` to `6.5`	
`10`	`9.0` to `11.5`	
`30`	`28.5` to `32`	

Table 9-6. `Paw` and `Ppat` values

Troubleshooting the expiratory valve linearity check

Problem Area	Symptom	Action
`Paw` `Ppat`	Values out of range.	Try replacing each of the following items in turn, repeating TSW 15.4 after each replacement: • *The expiratory valve cover. (See* Section 11.13.6, *Replacing the expiratory valve positioning coil*, on page 11-67.) • The expiratory valve membrane. (See Section 11.13.6, *Replacing the expiratory valve positioning coil*, on page 11-67.) • The expiratory valve complete. *(See* Section 11.13.6, *Replacing the expiratory valve positioning coil*, on page 11-67.*)* **Note** If you replace an item and successfully repeat TSW 15.4, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

TSW 15.5 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`** (or the local language equivalent).

TSW 16: Nebulizer

TSW 16.1 Overview

This test unit enables you to check the compressor and valve that provide air for an optional nebulizer.

TSW 16.2 Background

As a part of this test unit, you will check that the nebulizer valve switches off the flow of gas to the nebulizer compressor.

To do this, you will first disconnect the nebulizer valve electronically, and then measure the flow of gas delivered by the nebulizer. With the valve not functioning, the flow of gas from the nebulizer should be very small.

Because your test equipment does not include a flow meter to measure the gas flow directly, you will measure it indirectly, by timing the pressure increase of the gas delivered by the nebulizer into a vessel of fixed volume.

To perform this test unit, you therefore require a watch with a seconds display to use as a timing device.

TSW 16.3 Preparation

Activate **`TSW 16: Nebulizer`**. You see a display similar to the following:

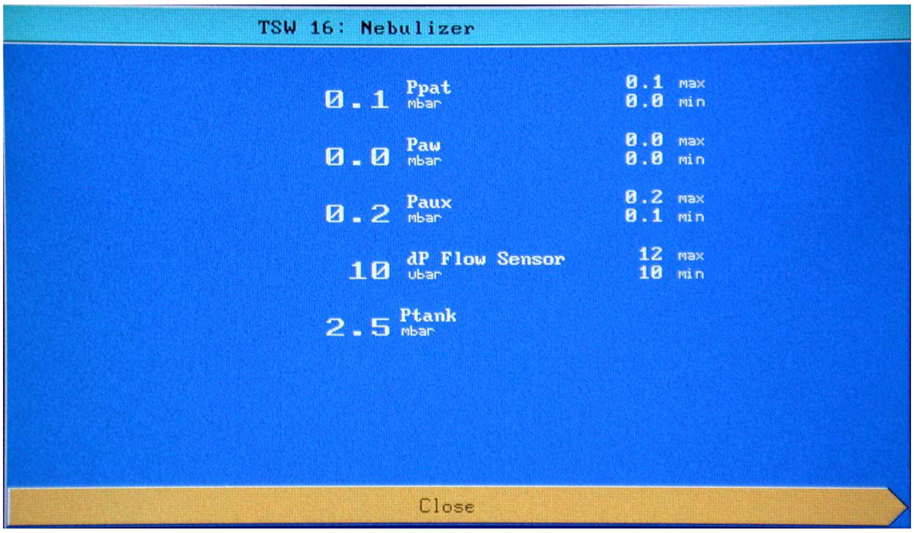


Figure 9-38. The `Nebulizer` screen

TSW 16.4 Performing the nebulizer compressor and valve checks

1. To check that the nebulizer valve switches off the flow of gas to the nebulizer compressor, do the following:
   a. Ensure that the nebulizer valve remains closed during the check, by temporarily disconnecting it from the connector board, as shown in Figure 9-39.

Note

It is acceptable to feel some blowing/sucking at the nebulizer connector when the nebulizer valve is closed.

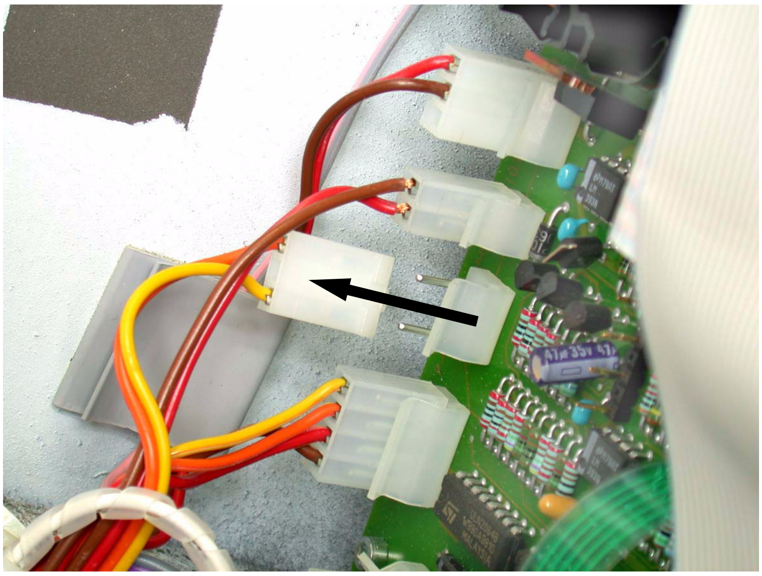


Figure 9-39. The nebulizer valve connector temporarily disconnected from the connector board

b. Construct a vessel of 630 ml volume by using two lengths of 110 cm patient tubing, as shown in Figure 9-40.
Notice that the auxiliary pressure (Paux) and nebulizer connectors are connected.

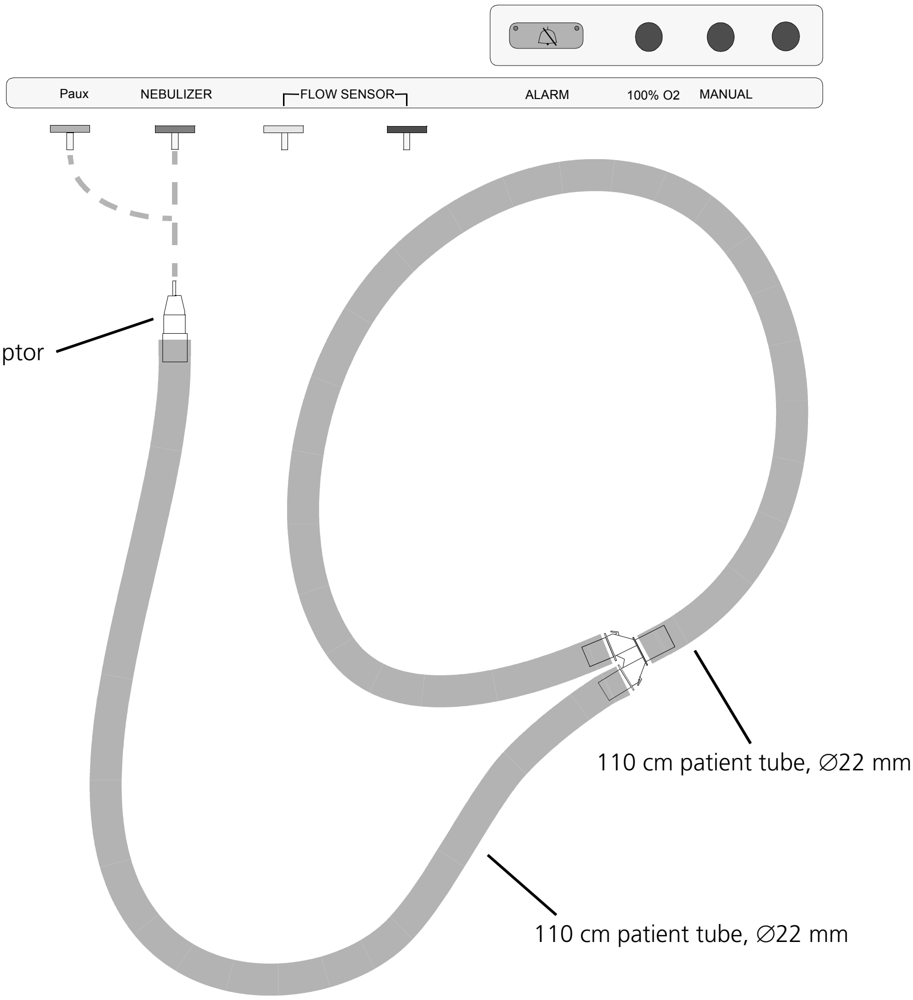


Figure 9-40. Setup for testing the nebulizer valve in the closed position

c. With GALILEO running, and the nebulizer valve still (electronically) disconnected, perform the following check:

Field	Function	Action	Check
`Paux`	Displays the pressure at the auxiliary pressure connector.	1. Disconnect a part of the tubing setup, to release any pressure in the patient tubing. 2. Wait until the nebulizer motor stops and then restarts, and reconnect the tubing. 3. Wait exactly 10 s while the nebulizer pumps gas into the patient tubing.	4. `Paux` must display less than `35.0` after 10 s.

d. Reconnect the nebulizer to the connector board. (This is a reversal of Figure 9-39 on page 9-75.)

2. Connect the pressure gauge to the nebulizer connector as shown in Figure 9-41, using a pressure probe suitable for measuring about 2000 mbar.

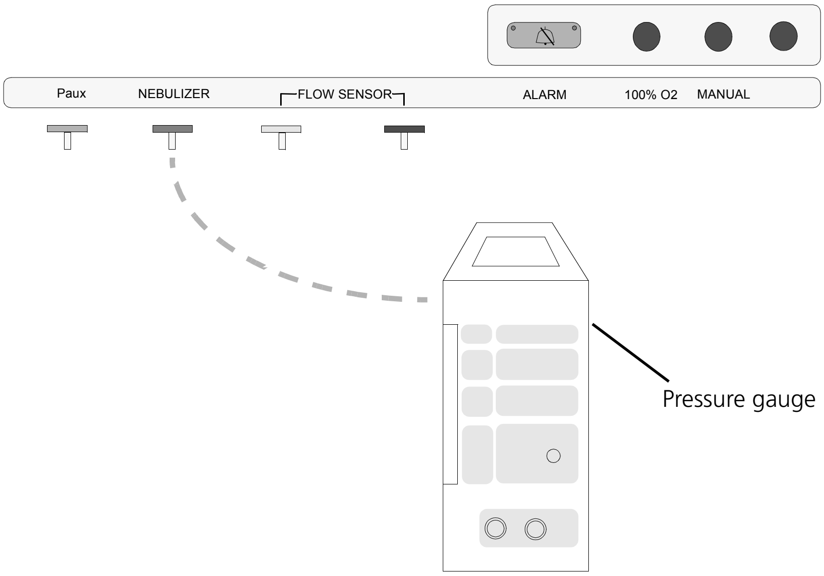


Figure 9-41. Setup for checking the nebulizer compressor and valve

a. Check that:
- The nebulizer valve repeatedly turns on for five seconds, and then off for five seconds. (This is shown by the pressure gauge.)
- The nebulizer compressor stops for 10 seconds after every 30 seconds. (The noise from the compressor stops completely.)

Figure 9-42 gives a graphical representation of this activity.

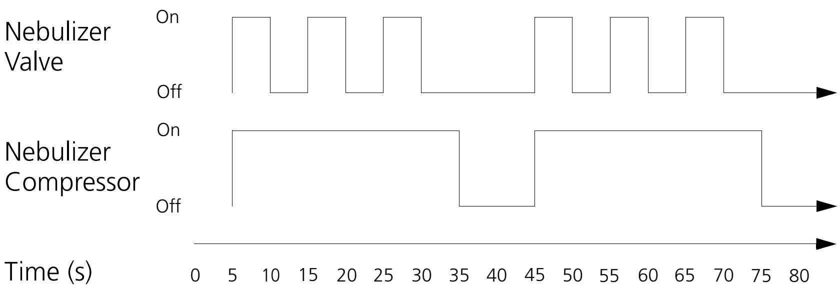


Figure 9-42. Nebulizer valve and compressor activity check

b. Check that when the nebulizer valve is open and the compressor is running, the pressure at the gauge is greater than 800 mbar.

3. Perform the following check:

Field	Function	Action	Check
`Ptank`	Displays the pressure in the tank. (The nebulizer compressor takes its gas supply from the tank.)	None.	`Ptank` must display `150` to `350`.

Troubleshooting the nebulizer compressor and valve checks

Problem Area	Symptom	Action
`Paux`	Pressure rises to more than `35.0` after 10 s during nebulizer valve test.	• Ensure that there is no leak into the nebulizer pump at the gas inlet (the tubing coming from the nebulizer valve to the top of the nebulizer pump). (See Section 4.22, *Nebulizer compressor and solenoid valve*, on page 4-62.) • Try replacing the nebulizer valve on the back of the nebulizer and repeating TSW 16.4. (Section 11.26.6, *Maintaining or replacing the nebulizer compressor and solenoid valve*, on page 11-153.) **Note** If you replace the nebulizer valve and successfully repeat TSW 16.4, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.
Pressure at pressure gauge	Pressure lower than 800 mbar when nebulizer running, and nebulizer valve open.	Try replacing each of the following items in turn, repeating TSW 16.4 after each replacement: • *Nebulizer solenoid valve. (*Section 11.26.6, *Maintaining or replacing the nebulizer compressor and solenoid valve*, on page 11-153*.)* • Nebulizer compressor membrane. *(*Section 11.26.6, *Maintaining or replacing the nebulizer compressor and solenoid valve*, on page 11-153*.)* • Nebulizer compressor. *(*Section 11.26.6, *Maintaining or replacing the nebulizer compressor and solenoid valve*, on page 11-153*.)* **Note** If you replace an item and successfully repeat TSW 16.4, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.

Problem Area	Symptom	Action
Nebulizer valve and compressor timing	Nebulizer valve and compressor do not switch on and off as shown in Figure 9-42, *Nebulizer valve and compressor activity check*, on page 9-77.	• *Verify that the cables from the nebulizer compressor and the nebulizer valve to the control board are properly in place, then repeat* TSW 16.4. • Try replacing the *control board, (*Section 11.11.6, *Replacing the control board and GMP assembly,* on page 11-52*) then repeating* TSW 16.4. **Note** If you replace an item and successfully repeat TSW 16.4, you must then perform all test software units, starting with *TSW 1: GMP Selftest*, on page 9-3.
`Ptank`	Pressure is not `150` to `350`.	Repeat TSW 10.3, *Performing the tank leakage check*, on page 9-46.

TSW 16.5 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`** (or the local language equivalent).

Note
You have now completed all the tests available in GALILEO's test mode.

3. As directed in Section 4.4, *Procedure*, on page 4-3:
   a. Lock all the potentiometer adjustment screws in place using proprietary locking paint or nail varnish.
   b. Close and screw shut the GALILEO.
   c. Perform the following tests, as described in the *GALILEO Intensive Care Ventilator Operator's Manual*:
   - Preoperational check
   - 3-month check

Section

10 Running Upgrade 2 test software

WARNING

- **Read Section 4, *Overview of preventive maintenance and testing*, before performing any of the tests in this section.**
- **If one of the tests indicates that you must replace a part, do this immediately, and then repeat the complete series of tests. You can find much more information about replacing parts in Section 11, *Component details and replacement procedures*.**

Note

- With software version 3.41f and later, if you switch off GALILEO while in normal ventilation mode and then switch it on again within one minute, GALILEO resumes normal ventilation. (This behavior is different to earlier software versions, in which the startup screen was always displayed after switching on, and the user always had to initiate ventilation.) The new behavior is for additional safety in the event of combined mains power and backup-battery failure. In such a case, if the GALILEO is quickly powered on, normal ventilation resumes immediately and automatically.
- To access the startup screen at any time, switch on GALILEO while keeping the Monitoring knob pressed.

10.1 Introduction

This section describes each of the units comprising the GALILEO Upgrade 2 (software version 3) test software. It applies to both GALILEO Gold and GALILEO “Classic”. If you have a GALILEO original or Upgrade 1, go to Section 9, *Running Original or Upgrade 1 test software*.

Before starting, be sure that you are familiar with *Typographic conventions* on page *Conventions-1*, and *Expressions* on page *Conventions-2*.

Consider also whether you must write a test report. Some hospitals require that you do this.

If you do not have a suitable form, you can photocopy and use the form named *GALILEO Upgrade 2 Test Report* at the back of this manual.

10.2 Functions of the test software units

Units in the test software perform the following functions:

- They display information (mostly concerning revisions and versions of GALILEO software and hardware)
- They enable you to run checks on GALILEO hardware and software
- They enable you to calibrate GALILEO hardware and software

In addition, *17: Event log check & export*, on page 10-94 enables you to access the *event log*. (Uniquely, this unit does not perform any tests or calibrations.)

10.3 Structure of this section

In this section, test software units are described using the following headings:

Overview	Always included. Read if you wish.
Background information	Sometimes included. Read if you wish.
Preparation	Always included. ***You must read and perform these sections***.
Performing checks Performing calibrations	One or several of these headings always included. You must read and perform all sections of this kind. Hint: Once you are familiar with a test, follow the shaded “fast track”.
Troubleshooting checks Troubleshooting calibrations	One or several of these headings always included. You must read and perform these sections only if you could not properly perform a test or calibration.
Completing this unit	Always included. ***You must read and perform this section***.

Note
In the troubleshooting sections, always perform the actions in the sequence specified.
Do not confuse the test-specific troubleshooting in this section, with Section 12, *General troubleshooting*.

10.4 Replacing parts

If one of the tests indicates that you must replace a part, do this immediately, and then repeat the complete series of tests.You can find much more information about replacing parts in Section 11, *Component details and replacement procedures*.

10.5 Entering test software mode

To start the series of test units that comprise the test software, you must put GALILEO into test software mode. If you want to run the test software, do this now:

1. Connect the GALILEO to the mains power supply.
2. Switch on the GALILEO, while at the same time holding down both the **MANUAL** and the **100% O2** keys for 5 seconds. The opening screen is displayed.
3. Using the control knob, select **`Test Mode`**. Press the control knob. A screen displaying **`1: Microprocessor checks`** is displayed.
4. Turn the control knob to select the test unit you require. Press the control knob to activate the test unit you have selected.

Note
- You must perform the tests in numerical order.
- After starting the test software with a GALILEO Upgrade 2, the audible alarm is stopped for 60 minutes, except for technical faults with the number TF 6000 and higher. The alarm remains stopped, as long as you are actively using the GALILEO in test software mode.

10.6 Exiting the test software mode

To exit test software mode, select **Exit** in the main bar. The GALILEO switches to the start up screen.

1: Microprocessor checks

Unit 1.1 Overview

This unit enables you to check the version or revision of:

- The GALILEO Main Processor (*GMP*)
- The GALILEO Control Processor (*GCP*)
- The GALILEO Press-&-Turn Processor (*GPT*)
- The GALILEO Interface Processor, where fitted (*GIP*)
- The *BIOS* and *operating system*
- The *control board*

In addition, you can check the date and the number of hours that the GALILEO has been in use.

Finally, when you start this unit, the GMP performs a self-test. You can also check the results of this.

Unit 1.2 Preparation

Activate **`1: Microprocessor checks`**. You see a display similar to Figure 10-1 or Figure 10-2

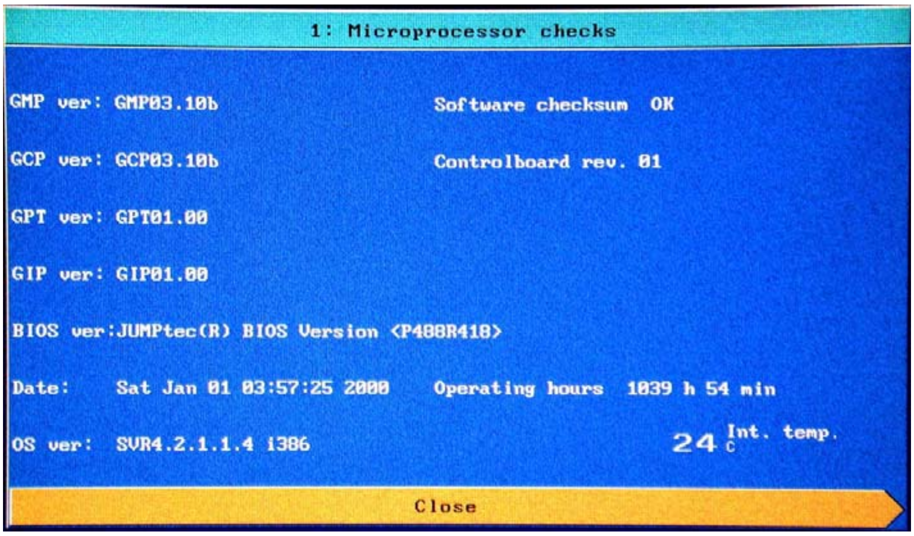


Figure 10-1. The `Microprocessor checks` screen with GMP 03.1*yz* software

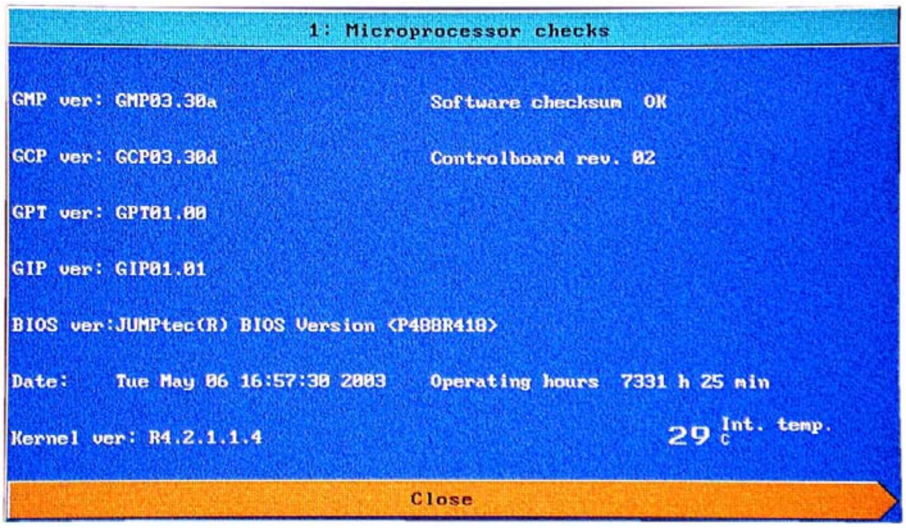


Figure 10-2. The `Microprocessor checks` screen with GMP 03.3*yz* software

Unit 1.3 Performing all checks

Perform all tasks marked with a grey background.

Field	Function	Check
`GMP ver:` `GCP ver:` `GPT ver:` `GIP ver:`	Display information about the software versions of the GMP, GCP, and GPT microprocessors. The GIP microprocessor is also included when the interface is fitted.	All software versions displayed must be compatible and should be the latest available. (If the software is not compatible, GALILEO will not ventilate.) See Appendix C, *GMP software/hardware compatibility*. If necessary, see the Service News, or general marketing information for information about upgrading.
`BIOS ver:`	Displays the BIOS version.	None.
`Date:`	Displays the current date and time.	Must display the correct date and time.
`OS ver:`	Displays the operating system version on GALILEOs with GMP 03.3yz software.	None.
Kernel ver:	Displays the kernel version on GALILEOs with 03.3yz software.	None.
`Software checksum:`	Displays the result of the cyclical redundancy test of the GMP software code.	Must display **`OK`**.
Controlboard rev:	Displays the revision of the control board.	None.
`Operating hours:`	Displays the total number of hours the GALILEO has been operating.	The number of operating hours must seem reasonable. Typically, a new unit already has 20 to 50 operating hours.
Int. temp.	Displays the internal operating temperature expressed in degrees Celsius as measured on the *control board*. The display range is **`10C`** to **`50C`**.	The internal temperature must be less than the sum of ambient temperature plus 10 degrees Celsius.

Troubleshooting all checks

Problem Area	Symptom	Action
`GMP ver:` `GCP ver:` `GPT ver:` `GIP ver:`	Software versions not latest available.	Consider upgrading. For the latest information, see the HAMILTON MEDICAL AG Partner Website (http://www.hamilton-medical.ch/partner-site).
	Software versions not compatible.	Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Problem Area	Symptom	Action
`Date:`	Date or time is not correct.	• Reset the date or time in the configuration menu, as described in the operators' manual for your GALILEO. • If the setting remains unstable, replace the 3 V battery, if fitted. (See Section 11.8.6, *Replacing the 3 V "button" battery*, on page 11-30.) • If the date setting still remains unstable, replace the GMP assembly and repeat Unit 1.3. (See Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.)
Software checksum:	**`OK`** is not displayed	Change the GMP software. (See Section 11.19.5, *Replacing the GMP CompactFlash*, on page 11-101.)
`Operating Hours:`	Number of hours unreasonably low	If you have exchanged the GMP program carrier (the GMP CompactFlash), you must set the operating hours to the value of the original board. You do this in the **`S/N Op. hours`** window, accessed under the **`Configuration`** menu.
	Number of hours unreasonably high	The most likely reason is that the GMP software was changed, and the number of operating hours was wrongly set after the change. Because it is only possible to set the number of operating hours once, it is not simple to correct this fault. Two courses of action are possible: • Obtain or create a record of the GALILEO's current configuration. Add to this a note that the operating hours displayed are higher than those really performed. • Replace the GMP program carrier, and set the operating hours again. You do this in the **`S/N Op. hours`** window, accessed under the **`Configuration`** menu.

Unit 1.4 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`**.

2: GPT–GMP communication & LED checks

Unit 2.1 Overview

This unit shows the result of a *GPT* check initiated in *1: Microprocessor checks*. It also automatically performs communication checks between the *GPT* and the *GMP* microprocessors immediately the unit is activated.

In this test unit you also manually check:

- The alarm LED
- The LCD display brightness
- The *emergency buzzer alarm* alarm
- The alarm relay for the communication interface

Note
You cannot perform any of the manual checks until the automatic communication checks are complete. This takes about 10 s.

Unit 2.2 Preparation

Activate **2: GPT-GMP communication & LED check**. You see a display similar to the following:

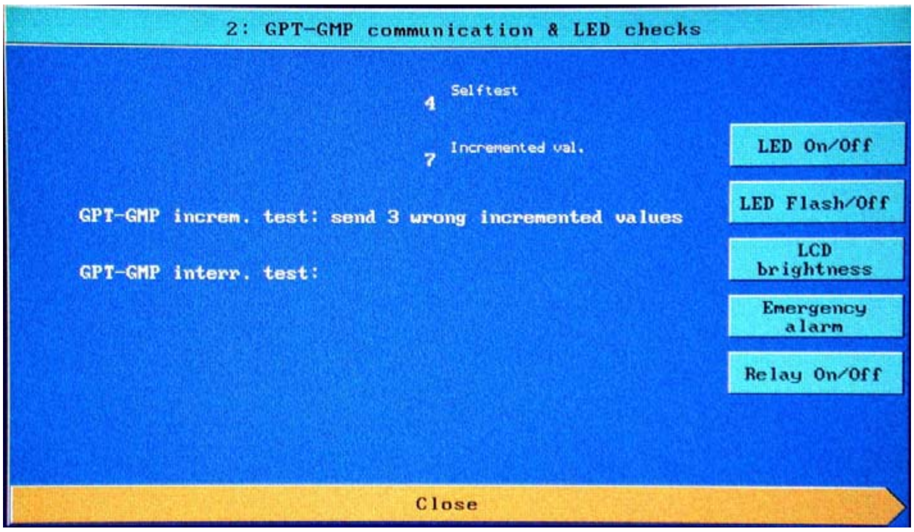


Figure 10-3. The GPT-GMP communication & LED check screen

When you first open the screen, you see the message **send 3 wrong incremented values** for a few seconds. This message is not important.

Unit 2.3 Performing the GPT and GMP checks

Perform all tasks marked with a grey background.

Field	Function	Check
GPT-GMP increm. test:	Displays the status and result of an incrementing communication check between the GPT and GMP.	Must display **Done**. (This takes about 5 seconds.)
GPT-GMP interr. test:	Displays the status and result of a communication interrupt check between the GPT and GMP.	Must display **Done**. (This takes about 10 seconds.)
Selftest	Displays the result of the GPT selftest.	Must display the number **4**. Any other number indicates that the GPT selftest was not successful.
Incremented val	Displays the current value of a communication check that runs continuously when the ventilator is functioning.	The value must increment (count upwards) in steps of two. The numbers displayed can be odd or even. (In other words, 1, 3, 5...31 or 2, 4, 6...30.) (Incrementing only begins when **GPT Testbyte:** and **GPT IRQ:** both display **Done**.)

Troubleshooting the GPT and GMP checks

Problem Area	Symptom	Action
GPT-GMP increm. test:	**Done** is not displayed.	Try replacing each of the following items in turn, repeating Unit 2.3 after each replacement: • *GMP* assembly. (Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.) • *GPT. (*Section 11.20.5, *Replacing the GPT controller*, on page 11-103.) **Note** If you replace an item and successfully repeat Unit 2.3, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.
GPT-GMP interr. test:	**Done** is not displayed.	
Selftest	A number other than **4** is displayed.	Try replacing the GPT controller, repeating Unit 2.3 after replacement. *(See* Section 11.20.5, *Replacing the GPT controller*, on page 11-103.) **Note** If you replace an item and successfully repeat Unit 2.3, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Problem Area	Symptom	Action
`Incremented val`	Does not repeatedly increment (count) to **`30`** or **`31`**.	Try replacing each of the following items in turn, repeating Unit 2.3 after each replacement: • *GMP* assembly. (Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.) • *GPT. (*Section 11.20.5, *Replacing the GPT controller*, on page 11-103.) **Note** If you replace an item and successfully repeat Unit 2.3, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 2.4 Performing the LED, LCD, and relay checks

Perform all tasks marked with a grey background.

Button	Function	Action	Check
`LED On/Off`	Switches the **ALARM** LED on the front panel on and off.	1. Activate **`LED On/Off`**. 3. Deactivate **`LED On/Off`**.	2. The **ALARM** LED on the left of the key on the front panel must switch on (Figure 10-4, *The ALARM LED on the front panel*, on page 10-12). 4. The **ALARM** LED must switch off.
`LED Flash/Off`	Causes the **ALARM** LED on the front panel to flash and to stop flashing.	1. Activate **`LED Flash/Off`**. 3. Deactivate **`LED Flash/Off`**.	2. The **ALARM** LED must flash. 4. The **ALARM** LED must stop flashing.
`LCD brightness`	Causes the LCD display to dim and brighten on some units.	1. Activate **`LCD brightness`**. 3. Deactivate **`LCD brightness`**.	2. The LCD display must dim. 4. The LCD display must return to its original brightness.
`Emergency alarm`	Switches the emergency buzzer on and off.	**Note** The emergency buzzer alarm makes a high frequency sound. It functions independently of the loudspeaker. 1. Activate **`Emergency alarm`**. 3. Deactivate **`Emergency alarm`**.	2. The emergency buzzer must sound, and you must hear the “click” of the 15 V relay closing. 4. The emergency buzzer must stop sounding, and you must hear the “click” of the 15 V relay opening.
`Relay On/Off`	Switches on and off the relay that operates the external nurse alarm.	**Note** You can only perform this check fully if you have an external nurse alarm connected to the external interface. 1. Activate **`Relay On/Off`** several times.	2. You must hear the click of the alarm relay opening and closing. 3. If connected, the external nurse alarm must operate.

Figure 10-4. **The ALARM LED on the front panel**

Troubleshooting the LED, LCD, and relay checks

Problem Area	Symptom	Action
`LED On/Off`	The **ALARM** LED does not switch on and off.	• Verify that the flat cables going from the keypad to the *control board* are properly in place, then repeat Unit 2.4. (The cable connectors on the connector board are numbered P15 and P416.) • Try replacing each of the following items in turn, repeating Unit 2.4 after each replacement: • Front panel keys. (See Section 11.16.5, *Replacing the front panel keys*, on page 11-86.) • The *connector board. (See* Section 11.10.6, *Replacing the connector board*, on page 11-40.) **Note** If you replace an item and successfully repeat Unit 2.4, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.
`LED Flash/Off`	The **ALARM** LED does not flash and stop flashing.	

Problem Area	Symptom	Action
`Emergency alarm`	The emergency buzzer alarm does not turn on and turn off.	• Verify that all connections to the *control board* are properly in place. (See Figure 11-56, *Control board PN 155461 connections*, on page 11-54.) • Verify that all connections to the *connector board* are properly in place. (See Figure 11-44, *Cable connections to connector board PN 155256 Revs 0 to 8*, on page 11-42.)
	The 15 V relay does not click open and click close.	
`Relay On/Off`	The alarm relay does not click open and click close.	
	The external nurse alarm does not operate.	Verify that the cable from the connector board to the interface connector on the rear of the GALILEO is in place and is properly connected.

Unit 2.5 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`**.

3: LCD display checks

Unit 3.1 Overview

This unit displays:

- The version of the *VGA graphics card*
- The version of the VGA *BIOS*

The test unit enables you to check:

- The LCD display colors
- The LCD display backlight
- The LCD display pixel alignment
- The dc/ac board

Unit 3.2 Preparation

Activate **`3: LCD display checks`**. You see a display similar to Figure 10-5 or Figure 10-6.

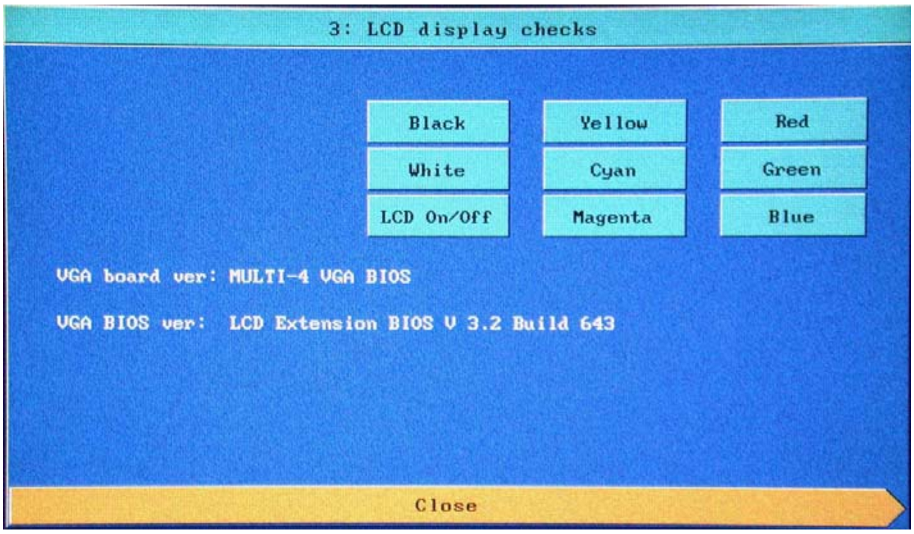


Figure 10-5. The `LCD display checks` screen with GMP 03.1*yz* software

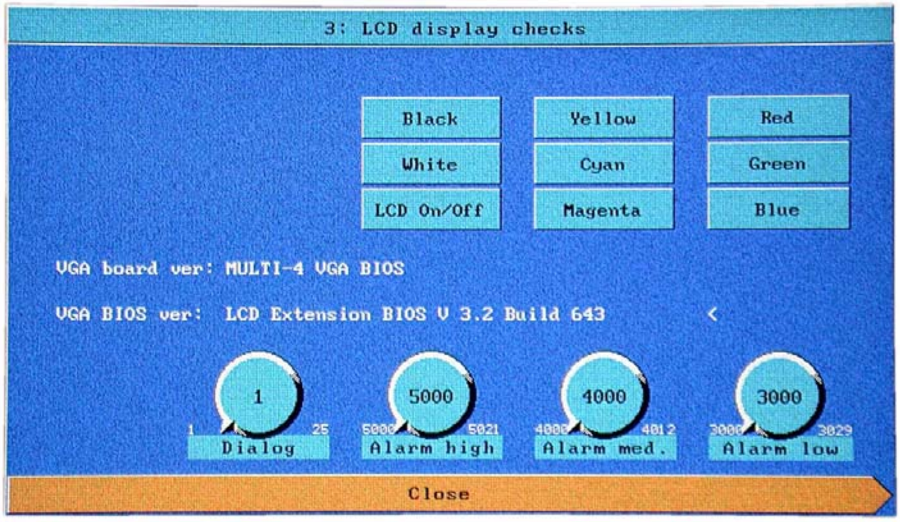


Figure 10-6. The `LCD display checks` screen with GMP 03.3*yz* software

Unit 3.3 Performing the VGA and BIOS version checks

Field	Function	Check
VGA board ver:	Displays the version of the Video Graphics Adapter (*VGA graphics card*) used by the display.	None.
VGA BIOS ver:	Displays the version of the BIOS of the VGA card.	None.

Unit 3.4 Performing the LCD display color checks

Perform all tasks marked with a grey background.

Button	Function	Action	Check
`Black` **`Yellow`** and so on	Each button tests the ability of the LCD display to display one color. **Note** The alarm symbol at the bottom right of the screen does not change color.	1. Activate a color button. 4. Deactivate the button. 6. Repeat for all buttons	2. The screen must show the appropriate color. 3. There must be no more than a cluster of 4 discolored pixels in any one place. 5. The screen must show the normal screen. 7. Results must alternate between the appropriate color and the normal screen.
`LCD On/Off`	Enables you to check that the LCD display backlight can be turned off and on.	1. Activate **`LCD On/Off`**. 3. Deactivate **`LCD On/Off`**.	2. The display must appear dark. 4. The display must show the normal screen.

Troubleshooting the LCD display color checks

<table>
<tr><th>Problem Area</th><th>Symptom</th><th>Action</th></tr>
<tr><td rowspan="2"><code>Black</code>
<code>Yellow</code>
and so on</td><td>There a total of more than 4 discolored pixels in one place.</td><td>Replace the LCD display and repeat Unit 3.4. (See Section 11.24.6, Replacing the LCD display and backlights, on page 11-127.)

Note
If you replace the LCD display and successfully repeat Unit 2.3, you must then perform all test software units, starting with 1: Microprocessor checks, on page 10-4.</td></tr>
<tr><td>One or more colors does not display.</td><td rowspan="2">Check that the wide ribbon cable attached to the top of the VGA graphics card is correctly positioned. (This is at the top of the GMP assembly.)
Try replacing each of the following items in turn, repeating Unit 3.4 after each replacement:
dc/ac board. The converter must be the Hitachi version, PN 155317. If it is the TDK version, PN 155415, you must replace it. (See Section 11.12.5, Replacing the dc/ac board, on page 11-63.)
GMP assembly. (See Section 11.11.6, Replacing the control board and GMP assembly, on page 11-52.)
LCD backlight. (See Section 11.24.6, Replacing the LCD display and backlights, on page 11-127.)
LCD display. (See Section 11.24.6, Replacing the LCD display and backlights, on page 11-127.)
Note
If you replace an item and successfully repeat Unit 3.4, you must then perform all test software units, starting with 1: Microprocessor checks, on page 10-4.</td></tr>
<tr><td rowspan="2"><code>LCD On/Off</code></td><td>LCD does not function.</td></tr>
<tr><td>LCD only partially lights up.</td><td>Ensure that both LCD backlights are properly connected to the dc/ac board. (See Section 11.24, LCD display and backlights, on page 11-125.)
Replace the faulty LCD backlight and repeat Unit 3.4.(See Section 11.24.6, Replacing the LCD display and backlights, on page 11-127.)
Note
Perform all test software units, starting with 1: Microprocessor checks, on page 10-4.</td></tr>
</table>

Unit 3.5 Performing the message and patient-alarm checks

Note

- These fields are displayed only by software version GMP 03.3yz.
- No action is required for Unit 3.5.

<table>
<tr><th>Field</th><th>Function</th><th>Check</th></tr>
<tr><td>Dialog</td><td>Enables translators to select and display all dialog messages, to check accuracy of spelling and translation.</td><td rowspan="4">None required.
However, you might choose to look through the messages, and contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch) if you can suggest improvements.</td></tr>
<tr><td>Alarm high</td><td>Enables translators to select and display all high priority patient alarm messages, to check accuracy of spelling and translation</td></tr>
<tr><td>Alarm med.</td><td>Enables translators to select and display all medium priority patient alarm messages, to check accuracy of spelling and translation</td></tr>
<tr><td>Alarm low</td><td>Enables translators to select and display all low priority patient alarm messages, to check accuracy of spelling and translation</td></tr>
</table>

Unit 3.6 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`**.

4: User interface & alarmtone checks

Unit 4.1 Overview

This unit enables you to check:

- The push-&-turn function of the monitoring knob
- The push-&-turn function of the control knob
- The three alarm-priority-level sounds generated by the loudspeaker
- The functions of all keys on the front keypad

Unit 4.2 Preparation

Activate **`4: User Interface & alarmtone checks`**. You see a display similar to the following:

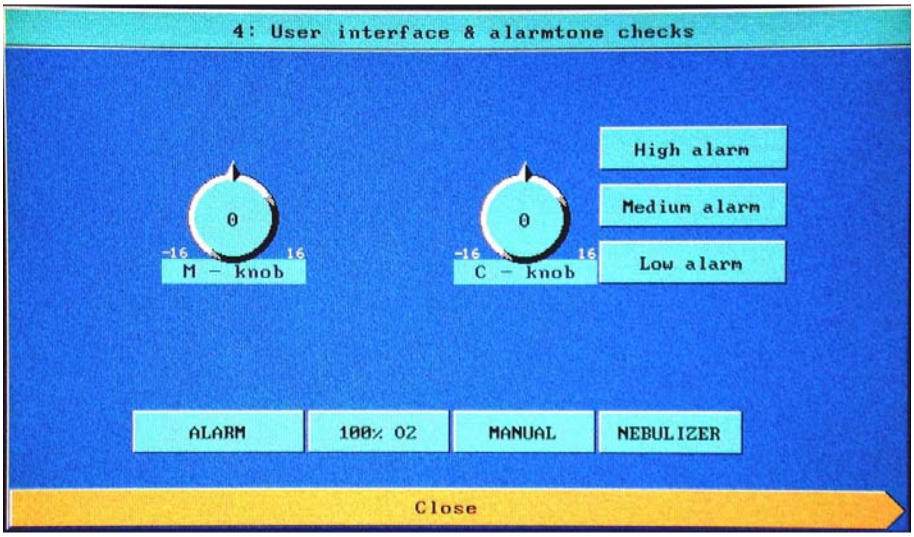


Figure 10-7. The `User Interface & alarmtone checks` screen

Unit 4.3 Performing the monitoring knob and control knob checks

Perform all tasks marked with a grey background.

Field	Function	Action	Check
M - knob "knob"	Enables a check of the pressing and turning functions of the monitoring knob.	1. Activate the **M - knob** "knob" on the LCD display by using the control knob in the normal way.	
		2. Slowly turn the monitoring knob on the front panel 16 clicks to the right.	3. Verify that the digital count on **M - knob** matches each movement of the monitoring knob.
		4. Return the **M - knob** "knob" to the neutral position (by turning the monitoring knob).	
		5. Turn the monitoring knob 16 clicks to the left.	6. Verify that the digital count on **M - knob** matches each movement of the monitoring knob, and is negative.
C - knob "knob"	Enables a check of the pressing and turning functions of the control knob.	1. Activate the **C - knob** "knob" on the LCD display by using the control knob in the normal way.	
		2. Slowly turn the control knob on the front panel 16 clicks to the right.	3. Verify that the digital count on **C - knob** matches each movement of the control knob.
		4. Return the **C - knob** "knob" to the neutral position (by turning the control knob).	
		5. Turn the control knob 16 clicks to the left.	6. Verify the digital count on **C - knob** matches each movement of the control knob, and is negative.

Troubleshooting the monitoring knob and control knob checks

Problem Area	Symptom	Action
Monitoring knob Control knob	Some or all of the 32-click range does not function.	• Verify that the very thin ribbon cable from the control knob encoder to the *connector board* is properly connected. (See Figure 11-43, *Removing a ribbon cable to a P&T-knob encoder*, on page 11-41.) • Replace the encoder and repeat Unit 4.3. (See Section 11.30.6, *Replacing an encoder*, on page 11-189.) **Note** If you replace the control knob encoder and successfully repeat Unit 4.3, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 4.4 Performing the audible alarm checks

Perform all tasks marked with a grey background.

Button	Function	Action	Check
`High alarm`	Enables you to check the high (most serious) audible alarm tone.	1. Activate **`High alarm`**. (You cannot deactivate this button.)	2. You must hear a series of 3 tones, followed by 2 tones. This series is continuously repeated. (Figure 10-8.)
Medium alarm	Enables you to check the medium (moderately serious) audible alarm tone.	1. Activate **`Medium alarm`**. (You cannot deactivate this button.)	2. You must hear a series of 3 tones, repeated after 25 s, and then after every 30 s. (Figure 10-8.) See note above.
Low alarm	Enables you to check the low (least serious) audible alarm tone.	1. Activate **`Low alarm`**. (You cannot deactivate this button.)	2. You must hear two tones. These are not repeated. (Figure 10-8.) See note above.

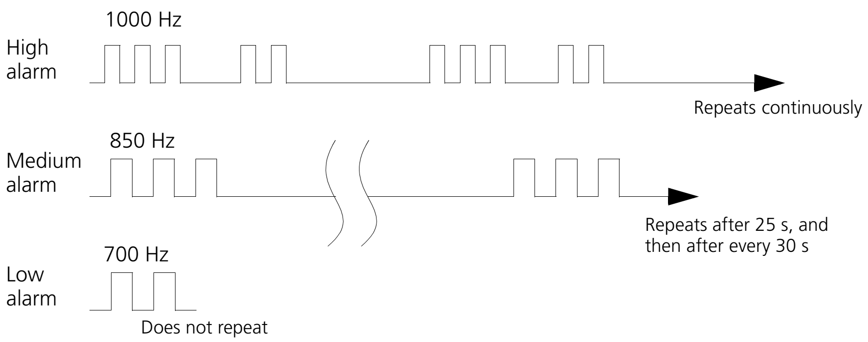


Figure 10-8. The high, medium and low alarm tones

Troubleshooting the audible alarm checks

Problem Area	Symptom	Action
High alarm Medium alarm Low alarm	Does not function as described in Figure 10-8.	• Verify that the loudspeaker is connected. • Verify that all cables to the *control board* are properly connected. (See Figure 11-56, *Control board PN 155461 connections*, on page 11-54.) • Verify that all cables to the *GMP* assembly are properly connected.

Unit 4.5 Performing the front-panel key checks

Perform all tasks marked with a grey background.

Button	Function	Action	Check
`ALARM`	Enables you to test the **ALARM** key.	1. Press and hold the **ALARM** key on the front panel keypad.	2. Ensure the **`ALARM`** button on the LCD display appears depressed as long as the key is pressed.
`100% O2`	Enables you to test the **100% O2** key.	1. Press and hold the **100% O2** key on the front panel keypad.	2. Ensure the **`100% O2`**button on the LCD display appears depressed as long as the key is pressed.
`MANUAL`	Enables you to test the **MANUAL** key.	1. Press and hold the **MANUAL** key on the front panel keypad.	2. Ensure the **`MANUAL`** button on the LCD display appears depressed as long as the key is pressed.
`NEBULIZER`	Enables you to test the (optional) nebulizer key.	**Note** This key is always present on the far right of the keypad. However, it is only labelled if the nebulizer option is included in the GALILEO. Where present, it is labelled with the nebulizer symbol: 	
		1. Press and hold the nebulizer key on the front panel keypad.	2. Ensure the **`NEBULIZER`** button on the LCD display appears depressed as long as the key is pressed.

Troubleshooting the front-panel key checks

Problem Area	Symptom	Action
`ALARM` `100% O2` MANUAL NEBULIZER	Button on LCD display does not appear depressed.	• Verify that the two very thin ribbon cables from the keypad to the *connector board* are properly connected. (See Figure 11-43, *Removing a ribbon cable to a P&T-knob encoder*, on page 11-41.) • Replace the keypad and repeat Unit 4.5. (See Section 11.16.5, *Replacing the front panel keys*, on page 11-86.) **Note** If you replace the keypad and successfully repeat Unit 4.5, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 4.6 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`**.

5: GCP–GMP communication checks

Unit 5.1 Overview

This unit enables you to check the results of a series of communication checks between the *GCP* and the *GMP*.

Unit 5.2 Preparation

Activate **`5: GMP-GMP communication checks`**. You see a display similar to the following:

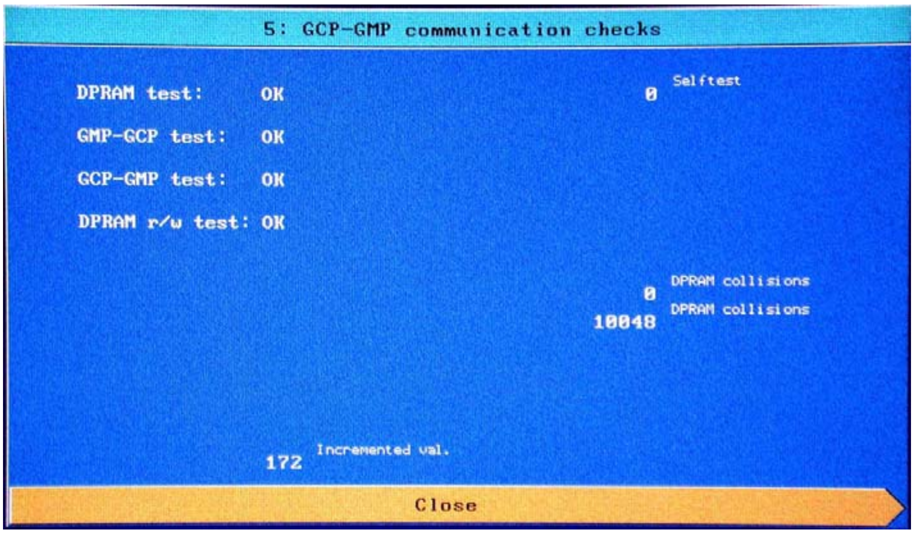


Figure 10-9. The `GMP-GMP communication checks` screen

Unit 5.3 Performing all checks

Perform all tasks marked with a grey background.

Field	Function	Check
DPRAM test:	Displays the results of a check for bad cells in the dual-ported RAM (DPRAM).	Must display **`OK`**.
GMP-GCP test:	Displays the result of a communication check from the GCP to the GMP.	Must display **`OK`**.
GCP-GMP test:	Displays the result of a communication check from the GCP.	Must display **`OK`**.
DPRAM r/w test:	Displays the result of a check in which the GMP and GCP write and read to the same address in the DPRAM at the same time. This activity causes addressing collisions.	Must display **`OK`** after a short time.
Selftest	Displays the result of a check the GCP performs on itself at startup.	Must display **`0`**.
DPRAM collisions DPRAM collisions	Displays the number of collisions that took place in the **`DPRAM r/w test`** (see above).	A value of 1000 or greater must be displayed in one or both of these fields.
Incremented val.	Displays the status and result of an incrementing communication check between the GPT and GMP.	The value displayed must increment (count upwards) from approximately 0 to approximately 255 in steps of 20. (The starting number is from 0 to 20. The finishing number is from 235 to 255.)

Troubleshooting all checks

Problem Area	Symptom	Action
DPRAM test: GMP-GCP test: GCP-GMP test: DPRAM r/w test:	**`OK`** is not displayed. A time-out error message is displayed.	Try replacing each of the following items in turn, repeating Unit 5.3 after each replacement: • *GCP*. (*See* Section 11.18.5, *Replacing the GCP EPROM*, on page 11-98.) • *GMP* assembly. (See Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.) • The *control board*. (See Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.) **Note** If you replace an item and successfully repeat Unit 5.3, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

<table>
<tr><th>Problem Area</th><th>Symptom</th><th>Action</th></tr>
<tr><td>Selftest</td><td>0 is not displayed.</td><td>Try replacing each of the following items in turn, repeating Unit 5.3 after each replacement:
• GCP. (See Section 11.18.5, Replacing the GCP EPROM, on page 11-98.)
• The control board. (See Section 11.11.6, Replacing the control board and GMP assembly, on page 11-52.)
If this fails, contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).
Note
If you replace an item and successfully repeat Unit 5.3, you must then perform all test software units, starting with 1: Microprocessor checks, on page 10-4.</td></tr>
<tr><td>DPRAM collisions</td><td rowspan="2">A value of 1000 or greater is not displayed in one or both of these fields.</td><td rowspan="2">Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).</td></tr>
<tr><td>DPRAM collisions</td></tr>
<tr><td>Incremented val.</td><td>Does not increment (count upwards).</td><td>Try replacing each of the following items in turn, repeating Unit 5.3 after each replacement:
• GCP EPROM. (See Section 11.18.5, Replacing the GCP EPROM, on page 11-98.)
• GMP assembly. (See Section 11.11.6, Replacing the control board and GMP assembly, on page 11-52.)
• The control board. (See Section 11.11.6, Replacing the control board and GMP assembly, on page 11-52.)
Note
If you replace an item and successfully repeat Unit 5.3, you must then perform all test software units, starting with 1: Microprocessor checks, on page 10-4.</td></tr>
</table>

Unit 5.4 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`**.

6: A/D converter check

Unit 6.1 Overview

In this test unit you check the performance of analog-digital converter U32 on the *control board*.

Unit 6.2 Background information

The test screen displays details of 16 analog signals from multiplexer U36 (on the control board). Each channel is converted by analog-digital converter U32, and the result displayed on the screen. In this test unit you confirm the performance of the AD converter by checking just four of these values.

Unit 6.3 Preparation

1. Ensure that the bridge (PN 155529) shown in Figure 10-10 is in place.

   This bridge enables the display of the measurement shown at **ADC 12** on the screen (Figure 10-11). When the bridge is in place, the (nominal) 5 V supply to the control board is displayed, as measured at analog-digital converter U32.

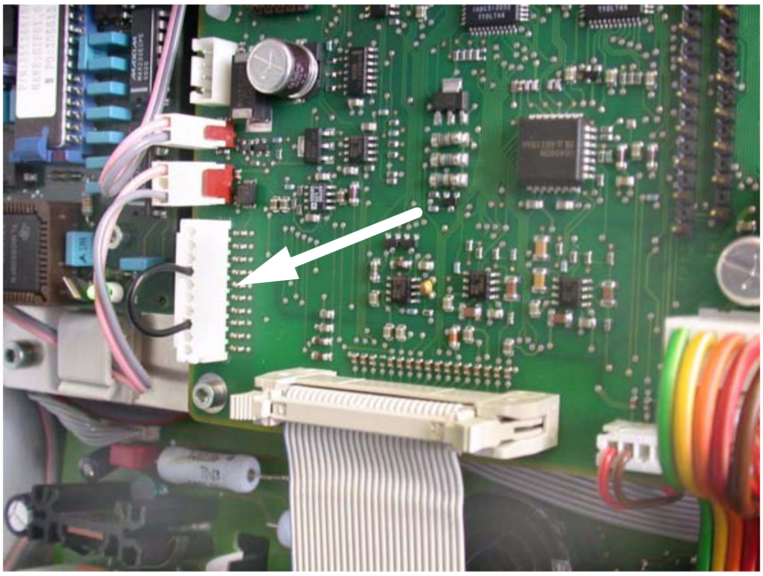


Figure 10-10. The bridge controlling the parameter displayed in ADC 12

2. Activate **`6: A/D converter check`**. You see a display similar to the following:

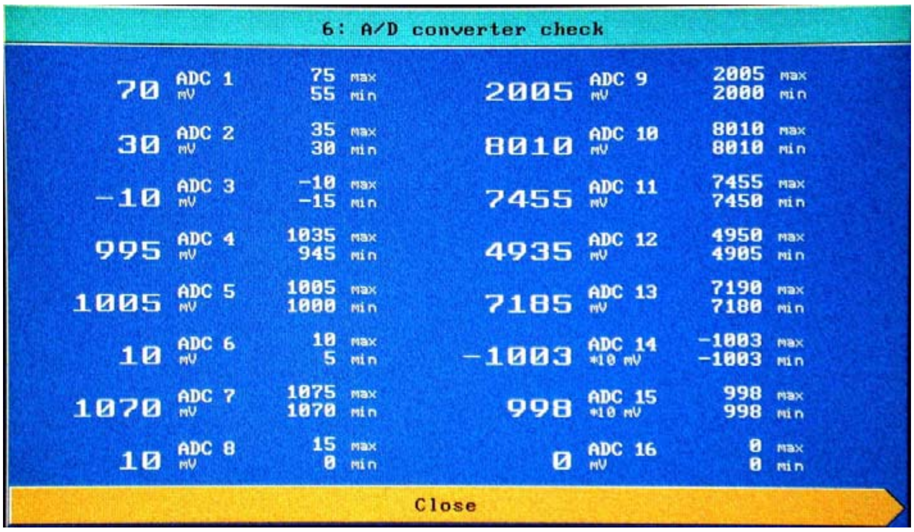


Figure 10-11. The `A/D converter check` screen

Unit 6.4 Performing all checks

Perform all tasks marked with a grey background.

Field	Function	Check
`ADC 1`	Analog-digital channel 1. Displays the voltage from the *Ppat* pressure sensor.	None.
`ADC 2`	Analog-digital channel 2. Displays the voltage from the *Paw* pressure sensor.	None.
`ADC 3`	Analog-digital channel 3. Displays the voltage from the *Paux* pressure sensor.	None.
`ADC 4`	Analog-digital channel 4. Displays the voltage from the *dP servo* pressure sensor.	None.
`ADC 5`	Analog-digital channel 5. Displays the square root (calculated analogically) of a voltage indicating gas flow from the *inspiratory (servo) valve*. This value is used internally, by GALILEO.	None.
`ADC 6`	Analog-digital channel 6. Displays the voltage from the *dP Flow Sensor* pressure sensor.	None.
`ADC 7`	Analog-digital channel 7. Displays the voltage from the *oxygen cell*.	None.
`ADC 8`	Analog-digital channel 8. This field is not currently used.	None.
`ADC 9`	Analog-digital channel 9. Displays the voltage of the analog signal to the *inspiratory (servo) valve*.	None.
`ADC 10`	Analog-digital channel 10. Displays the voltage of the analog signal to the *expiratory valve*.	None.
`ADC 11`	Analog-digital channel 11. Displays the value of the (nominal) 15 V power supply to the GALILEO. However, because of display limitations, the value shown on screen is half of the real value supplied.	None.
`ADC 12`	Analog-digital channel 12. Displays the value of the (nominal) 5 V power supply to the GALILEO, providing the bridge (Figure 10-10 on page 10-26) is in place.	The **`max`** and **`min`** values displayed must both be in the range: **`4850`** to **`5250`**.

Field	Function	Check
ADC 13	Analog-digital channel 13. Displays the voltage from the temperature measurement resistor.	None.
ADC 14	Analog-digital channel 14. Displays the value of the (nominal) -10 V supply to the pressure sensors.	The **max** and **min** values displayed must both be in the range: **-990** to **-1010**.
ADC 15	Analog-digital channel 15. Displays the value of the (nominal) 10 V power supply to the *inspiratory (servo) valve*.	The **max** and **min** values displayed must both be in the range: **990** to **1010**.
ADC 16	Analog-digital channel 16. Displays the ground voltage.	The **max** and **min** values displayed must both be in the range: **-10** to **10**.

Troubleshooting all checks

Problem Area	Symptom	Action
ADC 12 **ADC 14** **ADC 15** **ADC 16**	Value is out of range.	Check all connections to the *connector board*. In particular, make sure that the cable connecting the *power supply* in the column is properly in place. (See Figure 11-44, *Cable connections to connector board PN 155256 Revs 0 to 8*, on page 11-42.) Try replacing each of the following items in turn, repeating this Unit 6.4 after each replacement: • Cable 9 (power supply to connector board). • Other cables. • Connector board. *(See* Section 11.10.6, *Replacing the connector board*, on page 11-40.) • Control board. *(See* Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.) • Power supply board. *(See* Section 11.29.8, *Replacing the power supply*, on page 11-179.) **Note** If you replace an item and successfully repeat Unit 6.4, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 6.5 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **Close**.

7: D/A converter check

Unit 7.1 Overview

In this test unit you check the performance of digital-analog converter U33, located on the *control board*.

Unit 7.2 Background information

When you activate this unit, the screen displays an input “knob” that you “turn” using the control knob. This action controls two digital signals that the *GCP* sends to DAC U33. (Figure 10-12.)

DAC U33 changes these digital signals to analog signals, and sends them to the inspiratory and expiratory valves, and to ADC U32.

ADC U32 measures the analog signals from U33, and sends corresponding digital signals to the screen (through the GCP), where they are displayed as **`ADC 9`** and **`ADC 10`**.

Because ADC U32 was tested in 6: *A/D converter check*, you know that the **`ADC 9`** and **`ADC 10`** readings shown on the screen are an accurate indication of the analog values they represent.

You might like to compare Figure 10-12 with the large schematics of the control board in Appendix I, *Schematics*.

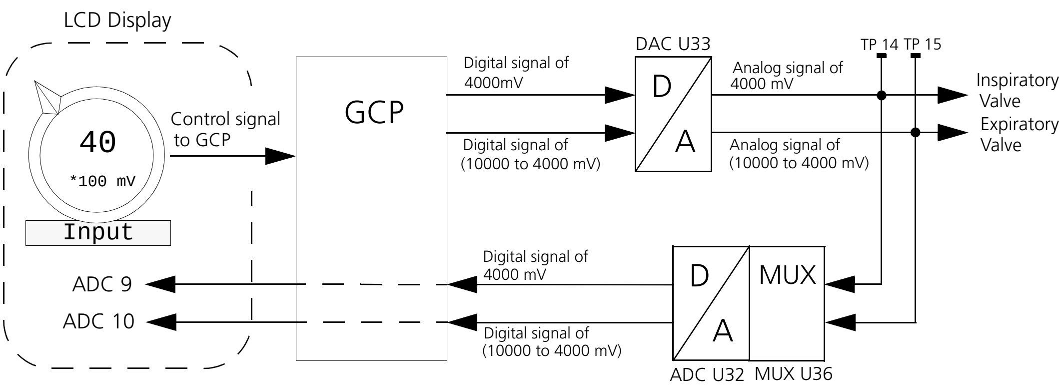


Figure 10-12. Sending digital signals corresponding to 4000 mV and 6000 mV to the inspiratory and expiratory valves

Unit 7.3 Preparation

Activate **`7: D/A converter check`**. You see a display similar to the following:

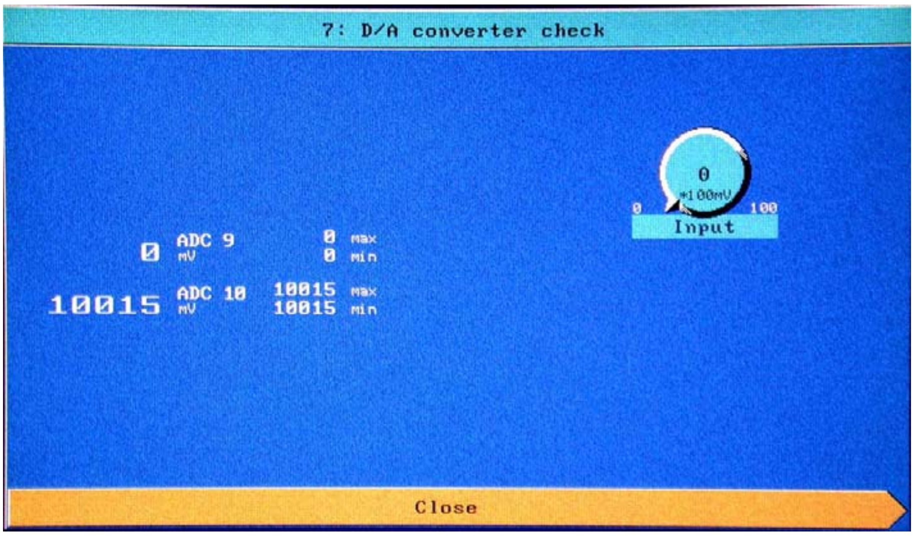


Figure 10-13. The `D/A converter check` screen

Unit 7.4 Performing all checks

Perform all tasks marked with a grey background.

Field	Function	Action	Check
Input "knob"	Enables you to send a digital value to digital-analog converter U33.	1. Activate the **Input** "knob" with the control knob in the normal way. 2. Turn the **Input** "knob" so that it displays **0**. Perform the **ADC 9** and **ADC 10** checks for **Input** "knob" **0**. (Table 10-1 on page 10-32.) 3. Repeat for values of **40** and **100**.	
ADC 9	Displays the value of the analog signal output from digital-analog converter U33, after that signal is converted back to digital. (This equals the signal set at the **Input** "knob" (plus or minus any inaccuracies resulting from the digital-analog-digital conversion.)		As described in the grey area above, the values displayed for **ADC 9** must be as shown on Table 10-1 on page 10-32.
ADC 10	Displays the value 10000, minus the value set at the **Input** "knob" (plus or minus any inaccuracies resulting from the digital-analog-digital conversion.)		As described in the grey area above, the values displayed for **ADC 10** must be as shown on Table 10-1 on page 10-32.

Input "knob"	**ADC 9**	**ADC 10**
0	**-10** to **10**	**9800** to **10200**
40	**3800** to **4200**	**5800** to **6200**
100	**9800** to **10200**	**-10** to **10**

Table 10-1. ADC 9 and ADC 10 values

Troubleshooting all checks

Problem Area	Symptom	Action
`ADC 9`	Values out of range.	Replace the *control board* and repeat *Unit 7.4*. (See Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.) **Note** If you replace the control board and successfully repeat Unit 7.4, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.
`ADC 10`		

Unit 7.5 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`**.

8: Zero and full-scale calibration

Unit 8.1 Overview

This test unit enables you to calibrate the zero and "full scale" points of most pressure sensors.

The only exceptions are the *dP Flow Sensor* full-scale calibration, which can only be checked, and the *dP mixer* full-scale calibration, which is performed in Unit 10.5, *Performing the mixer calibration*.

Note
In this context, "full scale" does not necessarily mean the highest possible point on the calibration scale. It means a point far enough removed from the zero point to enable an accurate calibration to take place.

Unit 8.2 Preparation

1. Disconnect from the GALILEO:
   - Patient tubing system
   - Air and oxygen supply
2. Disconnect the tubing from the *mixer* block. (Figure 10-14.)

Figure 10-14. **The tubing disconnected from the mixer block**

3. Locate the potentiometers and test pins that you will use to adjust the pressure sensors. These are positioned on:
   - The servo board. This is located to one side of the inspiratory valve as shown on Figure 10-15.
   - The sensor board. This is located under the mixer, as shown on Figure 10-16.

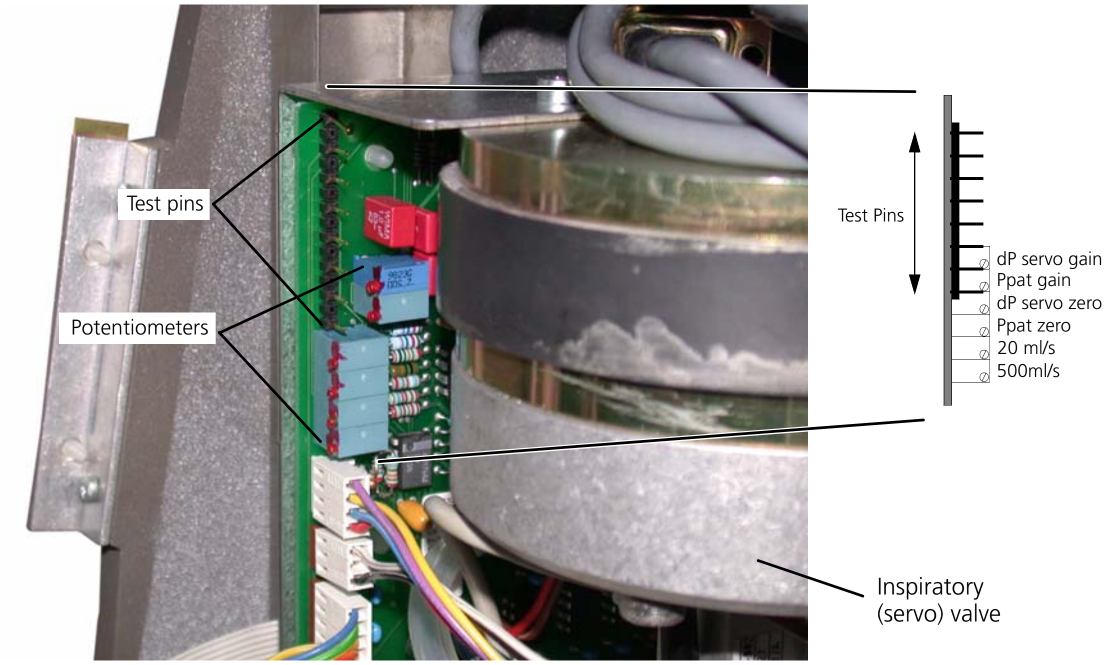


Figure 10-15. Location of the potentiometers on the inspiratory (servo) valve board

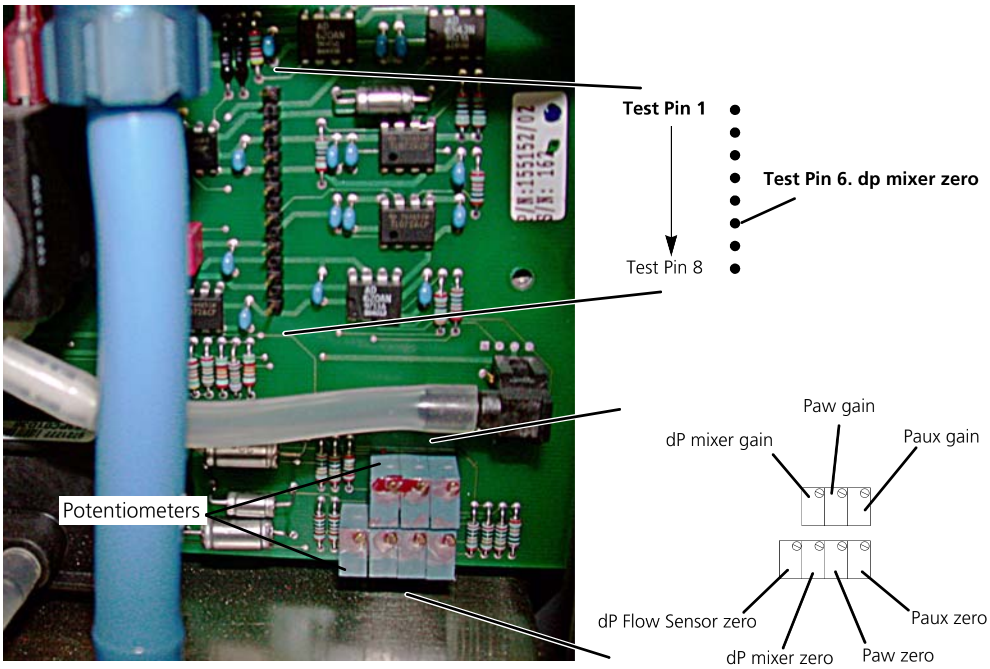


Figure 10-16. Location of the potentiometers and test pins on the sensor board

4. Activate **`8: Zero and full-scale calibration`**. You see a display similar to the following:

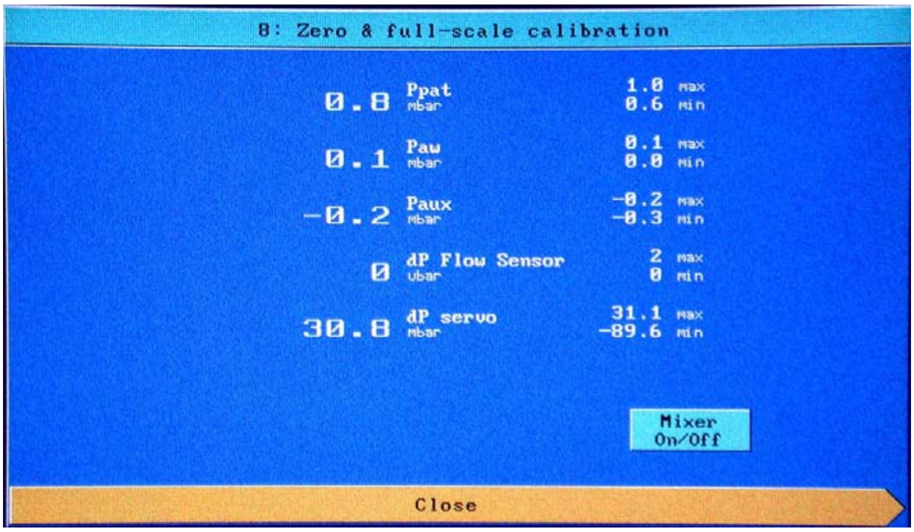


Figure 10-17. The `Zero & full-scale calibration` screen

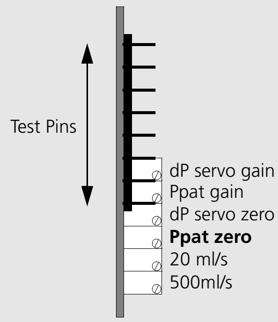
Unit 8.3 Performing the Ppat, Paw, Paux, and dP servo zero calibrations

Perform all tasks marked with a grey background.

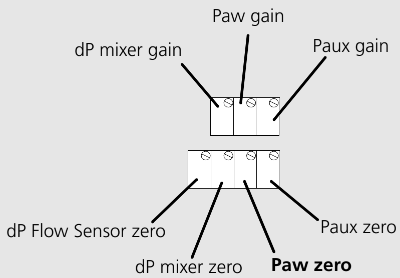
Note

If necessary, before performing these tasks, run GALILEO in any mode (including test software mode) for 15 minutes to make sure all parts are at a warm operating temperature.

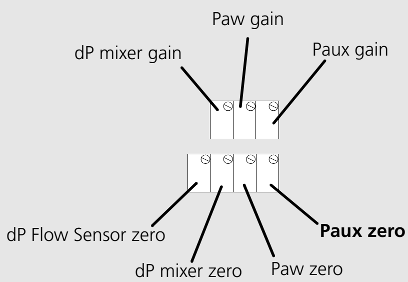
<table>
<tr><th>Field</th><th>Function</th><th>Action</th></tr>
<tr><td>Ppat</td><td>Displays patient pressure: a measurement of the pressure in the patient breathing circuit as measured at the inspiratory valve.</td><td>Adjust potentiometer Ppat zero on the servo board (shown below, and in Figure 10-15 on page 10-35) until Ppat displays: 0.0 ±0.1



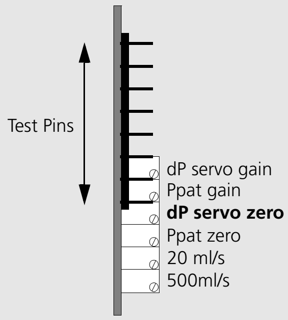
</td></tr>
<tr><td>Paw</td><td>Displays patient airway pressure.</td><td>Adjust potentiometer Paw zero on the sensor board (shown below, and in Figure 10-16 on page 10-35) until Paw displays: 0.0 ±0.1



</td></tr>
<tr><td>Paux</td><td>Displays auxiliary pressure.</td><td>Adjust potentiometer Paux zero on the sensor board (Figure 10-16 on page 10-35) until Paux displays: 0.0 ±0.1



</td></tr>
</table>

Field	Function	Action
`dP servo`	Displays differential servo pressure: the pressure difference between the inflow and outflow sides of the inspiratory valve.	Adjust potentiometer *dP servo zero* on the servo board (shown below, and in Figure 10-15 on page 10-35) until **`dP servo`** displays: **`0.0`** ±0.3 

Troubleshooting the Ppat, Paw, Paux, and dP servo zero calibrations

Problem Area	Symptom	Action
`Ppat` `Paw` `Paux` `dP servo`	After correct adjustment, later moves out of range Cannot adjust to within range	• Ensure the tubing shown in Figure 10-14 on page 10-34 is disconnected. • Try replacing the following items in turn, repeating Unit 8.3 after each replacement: • The *sensor board*. (See Section 11.31.4, *Replacing the sensor board*, on page 11-195.) • The *servo board*. (See Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111.) **Note** If you replace an item and successfully repeat Unit 8.3, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 8.4 Performing the dP mixer zero calibration

1. Attach your volt meter to Test Pin 1 (ground) and Test Pin 6 on the sensor board. (Figure 10-16 on page 10-35.)
2. Adjust potentiometer *dP mixer zero* (shown in Figure 10-18 below, and in more detail in Figure 10-16 on page 10-35) until the volt meter reads **0** ±**5** mV.

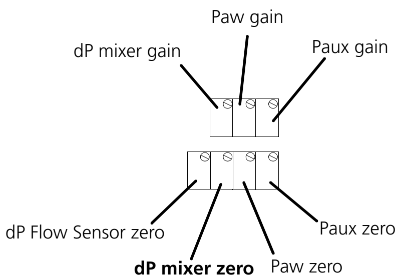


Figure 10-18. The dP mixer zero potentiometer

Troubleshooting the dP mixer zero calibration

Problem Area	Symptom	Action
dP Mixer Zero	Cannot adjust to within range.	• Ensure the tubing shown in Figure 10-14 on page 10-34 is disconnected. • Try replacing each of the following items in turn, repeating Unit 8.4 after each replacement: • Sensor board. (See Section 11.31.4, *Replacing the sensor board*, on page 11-195.) • Control board. (See Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.) **Note** If you replace an item and successfully repeat Unit 8.4, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 8.5 Performing the dP Flow Sensor zero calibration

1. Reconnect the tubing to the mixer.
2. Connect to the GALILEO:
   - Air
   - Oxygen
3. Connect a Flow Sensor (but without patient tubing) to the GALILEO. (Figure 10-19.)

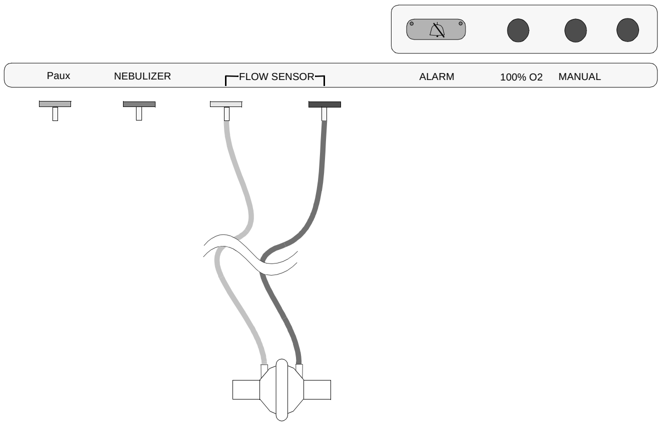
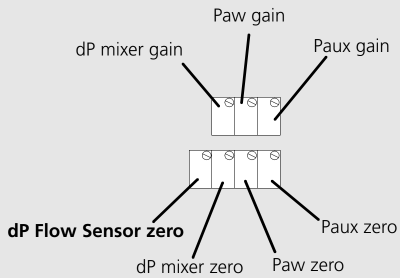


Figure 10-19. The Flow Sensor connected to the GALILEO

4. Activate **`Mixer On`**.
5. Make the following adjustment:

Field	Function	Action
`dP Flow Sensor`	Displays the pressure at the Flow Sensor's differential pressure sensor.	Adjust potentiometer *dP Flow Sensor zero* on the sensor board (shown below, and in Figure 10-16 on page 10-35) until **`dP Flow Sensor`** displays: **`0.0`** ±40.0 

Troubleshooting the dP Flow Sensor zero calibration

Problem Area	Symptom	Action
`dP Flow Sensor`	Cannot adjust to within range.	• Ensure the Flow Sensor tubing is properly connected, both inside and outside the GALILEO, and try repeating Unit 8.5. • Try replacing the sensor board, and then repeating Unit 8.5. (See Section 11.31.4, *Replacing the sensor board*, on page 11-195.) **Note** If you replace the sensor board and successfully repeat Unit 8.5, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 8.6 Performing the Ppat, Paw, and Paux full-scale calibrations

1. Build and connect the tubing setup shown in Figure 10-20.

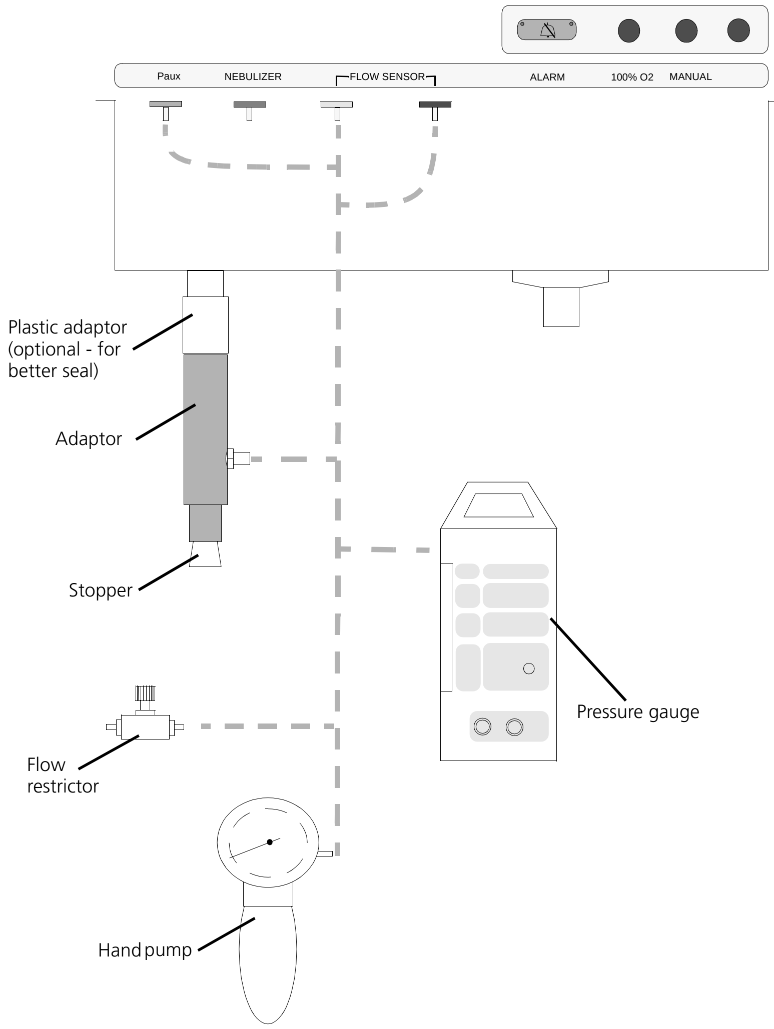
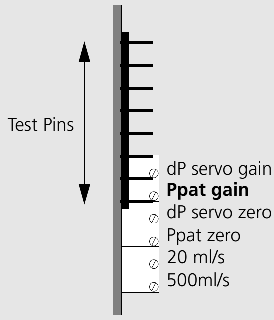
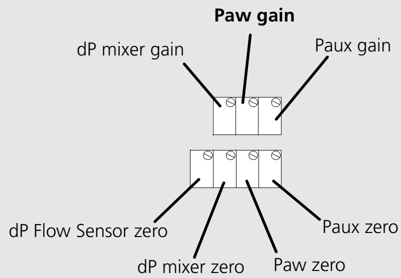
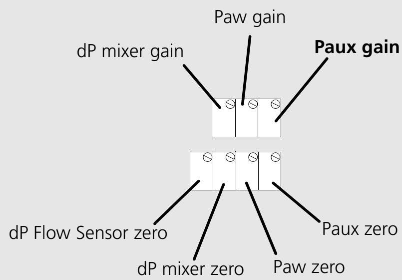


Figure 10-20. Setup for the Ppat, Paw, and Paux full-scale calibrations

2. Generate a pressure of approximately 80 mbar—as measured at the pressure gauge—by using the hand pump. (Sometimes you must gently press the pump to maintain the pressure. Sometimes you must use the flow restrictor so that you can continually release the air that enters the tubing from inspiratory (servo) valve leakage.)

3. Perform the following adjustments:

Field	Function	Action
`Ppat`	Displays patient pressure: a measurement of the pressure in the patient breathing circuit as measured at the *Ppat pressure sensor*, at the inspiratory valve.	Adjust potentiometer *Ppat gain* on the servo board (shown below, and in Figure 10-15 on page 10-35) until **`Ppat`** displays the same value as the pressure gauge, working to a tolerance of ±5%. (Therefore, if the pressure gauge reads 80 mbar, **`Ppat`** can display 76 to 84 mbar.) 
`Paw`	Displays patient airway pressure	Adjust potentiometer *Paw gain* on the sensor board (shown below, and in more detail in Figure 10-16 on page 10-35), until **`Paw`** displays the same value as the pressure gauge, working to a tolerance of ±5%. 
`Paux`	Displays auxiliary pressure	Adjust potentiometer *Paux gain* on the sensor board (shown below, and in more detail in Figure 10-16 on page 10-35), until **`Paux`** displays the same value as the pressure gauge, working to a tolerance of ±5%. 

Troubleshooting the Ppat, Paw, and Paux full-scale calibrations

Problem Area	Symptom	Action
Ppat Paw Paux	Cannot adjust to within range.	Try replacing each of the following items in turn, repeating Unit 8.6 after each replacement: • The *inspiratory (servo) valve* and *servo board* module. *(See* Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111.*)* • Sensor board. (See Section 11.31.4, *Replacing the sensor board*, on page 11-195.) **Note** If you replace an item and successfully repeat Unit 8.6, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 8.7 Performing the dP Flow Sensor full-scale check

1. Build and connect the tubing setup shown in Figure 10-21. Use a probe suitable for measuring 10 mbar. The tubing is attached to the silver Flow Sensor connector.

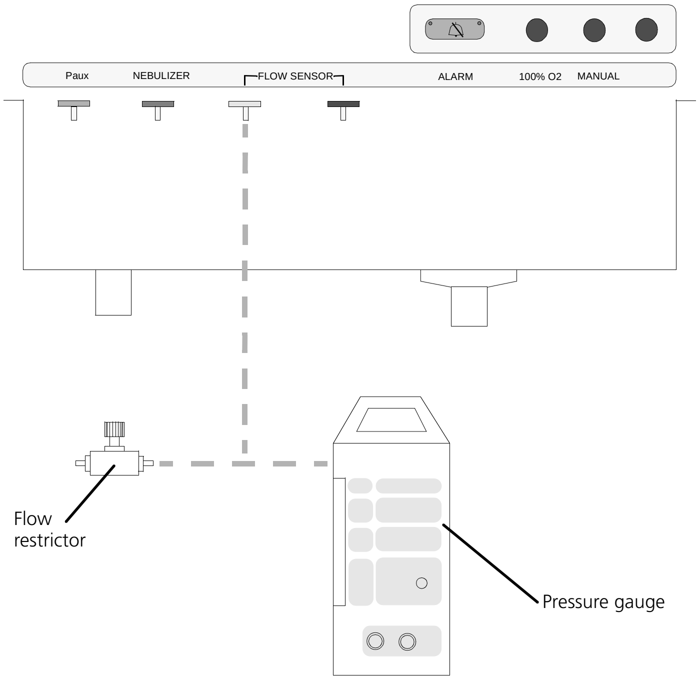


Figure 10-21. Setup for the Flow-Sensor full-scale check

2. Generate a pressure of approximately 2.5 mbar—as measured at the pressure gauge—by using the flow restrictor.
3. Perform the following check:

Parameter	Function	Check
`dP Flow Sensor`	Displays the Flow Sensor differential pressure.	`dP Flow Sensor` must read the same as the pressure gauge, to an accuracy of ±0.2 mbar. **Note** `dP Flow Sensor` is displayed in µbars, not mbars.

4. Remove the tubing from the silver connector, and attach it to the blue connector.
5. Generate a pressure of 2.5 mbar by using the flow restrictor.

6. Perform the following check:

Parameter	Function	Check
`dP Flow Sensor`	Displays the Flow Sensor differential pressure.	`dP Flow Sensor` must display a negative value the same as the positive value on the pressure gauge, to an accuracy of ±0.2 mbar. **Note** `dP Flow Sensor` is displayed in μbars, not mbars.

Troubleshooting the dP Flow Sensor full-scale check

Problem Area	Symptom	Action
`dP FLow Sensor`	Value is out of range.	• Ensure the Flow Sensor tubing is properly connected, both inside and outside the GALILEO, and try repeating Unit 8.7. • Try replacing the *sensor board* and then repeating Unit 8.7. (See Section 11.31.4, *Replacing the sensor board*, on page 11-195.) **Note** If you replace an item and successfully repeat Unit 8.7, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 8.8 Performing the dP servo full-scale calibration

1. Remove the tubing from the inspiratory valve. (Figure 10-22.)

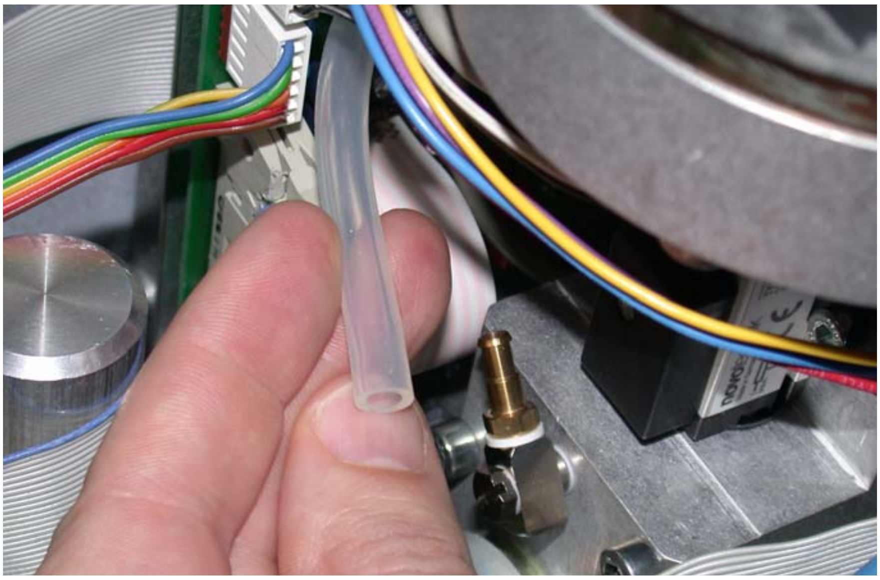


Figure 10-22. Tubing removed from the inspiratory valve

2. Build and connect the tubing setup shown in Figure 10-23 and Figure 10-24. On the pressure gauge use a probe suitable for reading approximately 500 mbar.
   A pressure of 200 to 500 mbar is generated by GALILEO.

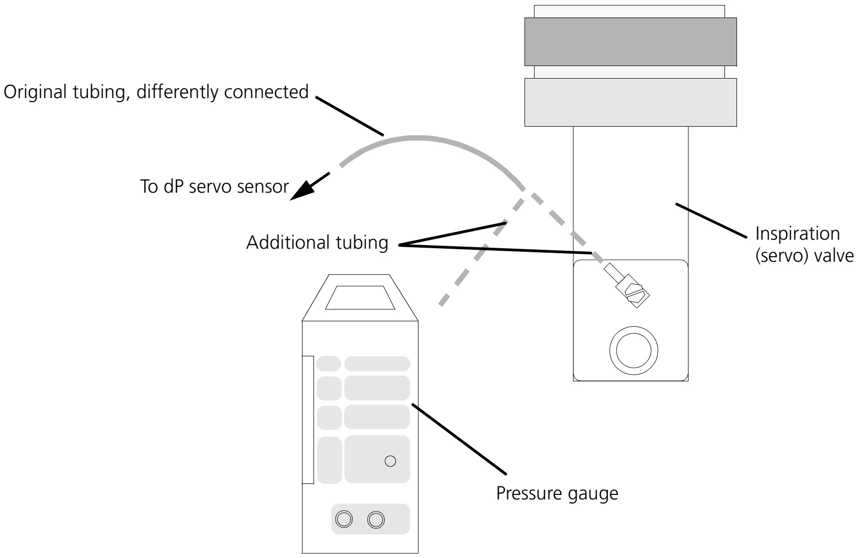


Figure 10-23. Setup for the dP servo full-scale calibration

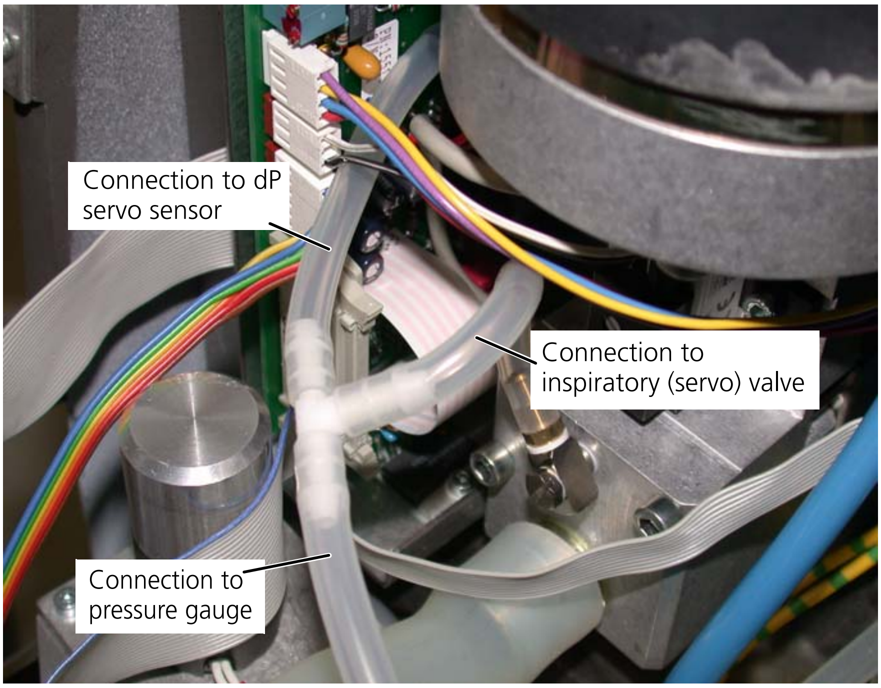


Figure 10-24. Tubing setup for the dP servo full-scale calibration

3. Perform the following adjustment:

Parameter	Function	Action
`dP servo`	Displays differential servo pressure: the pressure difference between the inflow and outflow sides of the inspiratory valve.	Adjust the *dP servo gain* potentiometer on the servo board (Figure 10-15 on page 10-35) until **`dP servo`** displays the same value as the pressure gauge, working to a tolerance of ±1 mbar.

4. Replace the tubing on the inspiratory valve.

Troubleshooting the dP servo full-scale calibration

Problem Area	Symptom	Action
`dP servo`	Cannot adjust to within range	Try replacing the *inspiratory (servo) valve* and *servo board* module (Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111), and repeating Unit 8.8. **Note** If you replace an item and successfully repeat Unit 8.8, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 8.9 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`**.

9: O2 cell calibration & check

Unit 9.1 Overview

This test unit enables you to:

- Calibrate the *oxygen cell*
- Check the calibration of the oxygen cell
- Test the oxygen-cell solenoid valves

Unit 9.2 Background information

The oxygen cell is calibrated at 100% oxygen for greatest accuracy, and the linearity of the measurement is tested at 50% oxygen, 21% oxygen (pure air) and 100% oxygen, at the end of the calibration.

Unit 9.3 Preparation

1. Ensure that the oxygen cell is installed. If it is a new cell, and has been stored in a refrigerator, leave it for at least half an hour to reach room temperature.
2. Connect the air and oxygen.
3. Activate **9: O2 cell calibration & check**. You see a display similar to the following:

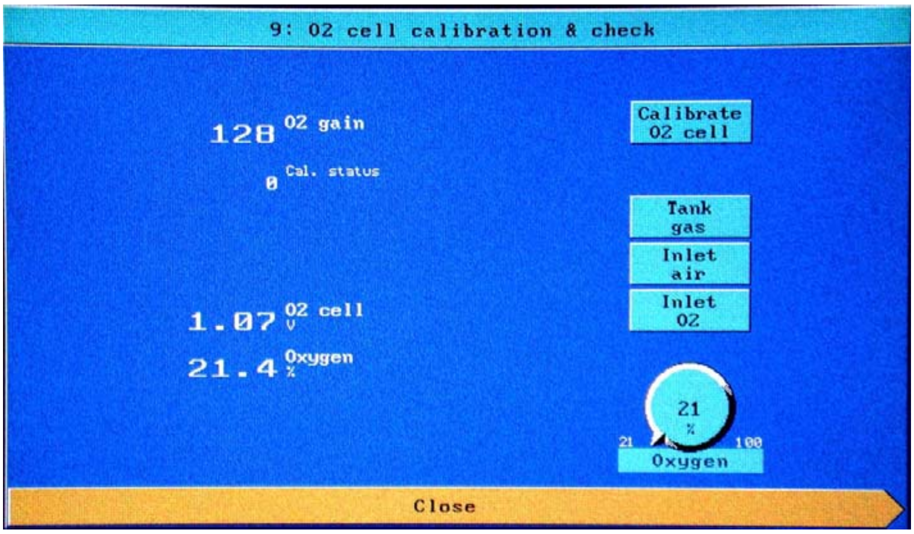


Figure 10-25. The O2 cell calibration & check screen

Unit 9.4 Performing the oxygen cell calibration

Perform all tasks marked with a grey background.

Field or Button	Function	Action	Check
`Calibrate O2 cell` (button)	Enables calibration of the oxygen cell. When activated, 100% oxygen is sent to the oxygen cell, and the voltage of the cell is measured. After a minute, air is sent and the voltage measured again.	1. Activate the **`Calibrate O2 cell`** button. 2. Wait two minutes while **`O2 Cell Cal. in progress`** is displayed.	3. Screen must display **`O2 Cell is calibrated`** (or your local language equivalent).
`Cal. status`	Displays the status of the calibration process. The value **`1`** indicates that the process is running. The value **`0`** indicates that the process is complete. **Note** The value **`0`** does not necessarily indicate a successful calibration.		4. **`Cal. status`** must display **`0`**.

Troubleshooting the oxygen cell calibration

Problem Area	Symptom	Action
`Calibrate O2 cell` (button)	**`O2 cell cal. needed`** (or your local language equivalent) is displayed. The calibration was not successful.	• Ensure that oxygen is connected. • Try replacing the O2 cell, and repeating this test. If the test is successful, it is not necessary to repeat all test software units. Continue to Unit 9.5, *Performing the oxygen cell calibration checks* • If the cell will not calibrate, continue to Unit 9.5, *Performing the oxygen cell calibration checks*, where you can isolate the fault.

Unit 9.5 Performing the oxygen cell calibration checks

Perform all tasks marked with a grey background.

Field or Button	Function	Action	Check
Oxygen "knob" **Note** This field is displayed in the local language.	Enables you to select the concentration of oxygen delivered by the mixer to the tank. The tank is flushed until the required concentration is reached. **Note** This field is displayed in the local language.	1. Activate the **Oxygen** "knob". 2. Turn the "knob" quickly, until **50** is displayed (50% oxygen). 3. Deactivate the "knob".	
Tank gas (button)	Enables you to send gas from the tank to the oxygen cell, thereby measuring the oxygen concentration in the tank set by the **Oxygen** "knob".	4. Activate the **Tank gas** button.	5. Ensure **O2 gain**, **O2 cell** and **Oxygen** are in the ranges shown on Table 10-2 on page 10-53.
Inlet air (button)	Enables you to send air to the oxygen cell, thereby measuring the concentration of oxygen in the air from the air inlet.	6. Activate the **Inlet air** button.	7. Ensure **O2 gain**, **O2 cell** and **Oxygen** are in the ranges shown on Table 10-2 on page 10-53.
Inlet O2 (button)	Enables you to send pure oxygen to the oxygen cell, thereby measuring the oxygen concentration in the gas from the oxygen inlet.	8. Activate the **Inlet O2** button.	9. Ensure **O2 gain**, **O2 cell**, and **Oxygen** are in the ranges shown on Table 10-2 on page 10-53.
O2 gain (field)	Displays the gain applied by GALILEO to the voltage from the oxygen cell. A higher gain indicates an older cell.	None.	As detailed in the grey sections above, ensure the value is in the range shown on Table 10-2 on page 10-53.
O2 cell (field)	Displays the voltage generated by the oxygen cell.	None.	As detailed in the grey sections above, ensure the value is in the range shown on Table 10-2 on page 10-53.
Oxygen (field)	Displays the concentration of oxygen being measured by the oxygen cell.	None.	As detailed in the grey sections above, ensure the value is in the range shown on Table 10-2 on page 10-53.

Field or Button	Function	Action	Check
Cal. status (field)	Displays the status of the calibration process. The value **1** indicates that the process is running. The value **0** indicates that the process is complete. **Note** The value **0** does not necessarily indicate a successful calibration.	None.	None.

Button Activated	Field		
	O2 gain	**O2 cell**	**Oxygen**
Tank gas (with 50% set on the **Oxygen** "knob")	**75** to **255**	**1.25** to **4.25**	**47** to **53**
Inlet air	**75** to **255**	**0.5** to **1.7**	**19** to **23**
Inlet O2	**75** to **255**	**2.5** to **8.5**	**98** to **100**

Table 10-2. **Values for Unit 9.5**

Troubleshooting the oxygen cell calibration checks

Problem Area	Symptom	Action
O2 gain (field)	Value too high	• Ensure that the air and oxygen supplies are functioning properly. • Repeat the oxygen cell calibration. • If cell calibration is unsuccessful, replace the oxygen cell and start this unit again. (It is not necessary to perform all test units again.) • Check the mixer valves and wiring.
	Value too low	• Ensure that the air and oxygen supplies are functioning properly.
O2 cell (field)	Value too high	• Ensure that the air and oxygen supplies are connected and functioning properly. • Repeat the oxygen cell calibration. • If cell calibration is unsuccessful, replace the oxygen cell and start this unit again. (It is not necessary to perform all test units again.) • Check the mixer valves and wiring.
	Value too low	The oxygen cell cannot create sufficient voltage because it is too old. Replace it.

Problem Area	Symptom	Action
Oxygen (field)	Value out of range with Tank gas button pressed	• Ensure that the air and oxygen supplies are connected and functioning properly. • Repeat the oxygen cell calibration. • If cell calibration is unsuccessful, replace the oxygen cell and start this unit again. (It is not necessary to perform all test units again.) • Check the oxygen cell solenoid valves. • Check the mixer valves and wiring.
	Value out of range with **Inlet air** button pressed	• Ensure that the air and oxygen supplies are connected and functioning properly. • Check the oxygen cell solenoid valves.
	Value out of range with **Oxygen** button pressed	• Ensure that the air and oxygen supplies are connected and functioning properly. • Ensure that the oxygen supplied is pure oxygen. • Check the oxygen cell solenoid valves.

Unit 9.6 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **Close**.

10: Mixer calibration & checks

Unit 10.1 Overview

This test unit enables you to check:

- Leakage from the *tank*
- Leakage from the *mixer*
- The functioning of the *mixer valves*
- The functioning of the *tank overpressure valve*

In addition, you calibrate the *mixer gain*, thereby setting the maximum pressure reached by the tank during the gas-inlet / gas-use cycle (although when flushed to create a new gas mixture, the tank reaches a higher pressure).

Unit 10.2 Preparation

1. Make sure that the oxygen cell, and the air and oxygen supplies remain in place.
2. Activate **`10: Mixer calibration & checks`**. You see a display similar to the following:

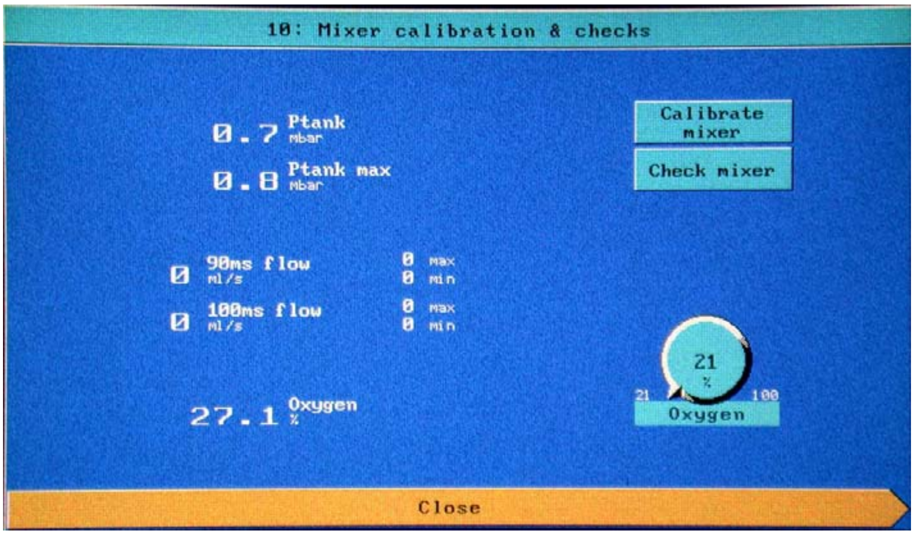


Figure 10-26. The `Mixer calibration & checks` screen

Unit 10.3 Performing the tank leakage check

This test checks for leaks both into, and out of, the tank.

Field	Function	Action	Check
`Ptank`	Displays the current tank pressure in millibars. During this check, the pressure decreases with time, because of tank gas is used for the rinse flow.	None.	Ensure that the time required for the tank to sink from 300 to 280 mbar is more than 8 seconds. **Note** You must perform this check before the tank pressure sinks below 300 mbar. If the tank pressure has already dropped below this limit, wait several minutes for the tank to repressurize itself.

Troubleshooting the tank leakage check

<table>
<tr><th>Problem Area</th><th>Symptom</th><th>Action</th></tr>
<tr><td rowspan="2"><code>Ptank</code></td><td>Tank pressure sinks too quickly. (There is a leak from the tank.)</td><td>

Check all connections to the tank:

All tubes, including the connection to the tank, and the connection to the other component.
The O-ring between the tank and the inspiratory (servo) valve. (See Section 11.22.6, Replacing the inspiratory valve / servo board assembly, on page 11-111, and particularly Figure 11-122, Inserting the new O-ring into its location, on page 11-115.)

Try replacing each of the following items in turn, repeating Unit 10.3 after each replacement:

The inspiratory (servo) valve. (See Section 11.22.6, Replacing the inspiratory valve / servo board assembly, on page 11-111.)
The tank overpressure valve. (See Section 11.33.6, Replacing the sintered disk and tank overpressure relief valve, on page 11-210.)

Note
If you replace an item and successfully repeat Unit 10.3, you must then perform all test software units, starting with 1: Microprocessor checks, on page 10-4.
</td></tr>
<tr><td>Tank pressure rises. (There is a leak from the mixer into the tank.)</td><td>

Try disconnecting the air supply at the rear of GALILEO. If the tank pressure continues to rise, replace the oxygen mixer inlet valve. (See Section 11.25.5, Replacing the mixer block or mixer valves, on page 11-144.) Repeat Unit 10.3.
If necessary, do the same with the oxygen supply and air mixer valve. Repeat Unit 10.3.

Note
If you replace an inlet valve and successfully repeat Unit 10.3, you must then perform all test software units, starting with 1: Microprocessor checks, on page 10-4.
</td></tr>
</table>

Unit 10.4 Performing the mixer valves checks

Perform all tasks marked with a grey background.

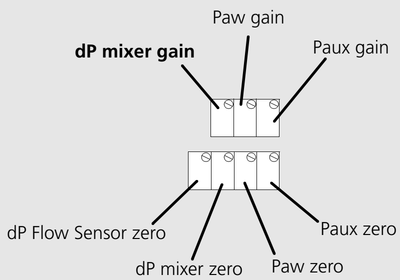
Field	Function	Action	Check
`90ms flow`	Displays the combined leakage flow from both mixer valves. This value is measured in milliliters per second, 90 milliseconds after the valves close.	None.	The value displayed must be in the range: **0** to **300** (It is very common that the value 0 is displayed. This does not suggest that the test did not function correctly.)
`100ms flow`	As for **`90ms flow`**, but measured after 100ms.	None.	The value displayed must be in the range: **0** to **200** (It is very common that the value **0** is displayed. This does not suggest that the test did not function correctly.)

Troubleshooting the mixer valves check

Problem Area	Symptom	Action
`90ms flow` `100ms flow`	Value is out of range.	• Try disconnecting the air supply at the rear of GALILEO. If the tank pressure continues to rise, replace the oxygen mixer inlet valve. (See Section 11.25.5, *Replacing the mixer block or mixer valves*, on page 11-144.) Repeat Unit 10.4. • If necessary, do the same with the oxygen supply and air mixer valve. Repeat Unit 10.4. **Note** If you replace a valve and successfully repeat Unit 10.4, you must then perform all test software units again, starting with Unit 1.1, *Overview*, on page 10-4.

Unit 10.5 Performing the mixer calibration

Perform all tasks marked with a grey background.

Field or Button	Function	Action	Check
`Calibrate mixer` (button)	Enables you to set the maximum pressure that can occur in the tank during the gas-inlet / gas-use cycle. (Higher pressures are reached when the tank is flushed to create a new gas mixture.) This operation calibrates the mixer in relation to the tank pressure currently measured by the pressure sensors on the servo board (which have already been calibrated).	1. Activate **`Calibrate mixer`** three times, each time completing a complete calibration cycle. (Three complete cycles are required to give consistent results.) 2. Adjust potentiometer *dP mixer gain* on the sensor board (shown below, and in more detail in Figure 10-16 on page 10-35) until **`Ptank max`** displays **`330`** to **`350`** mbar. **Note** You must start with a pressure higher than 340 mbar, and adjust downwards to compensate for hysteresis in the tank. 	
`Ptank max` (field)	Displays the maximum pressure setting for the tank. Pressure in the tank should not be able to rise above this value in normal (non-test) operation.		3. The value displayed must be in the range **`330`** to **`350`** after calibration.

Troubleshooting the mixer calibration

Problem Area	Symptom	Action
`Ptank max`	Cannot adjust into range.	Try replacing each of the following items in turn, repeating Unit 10.5 after each replacement: • Sintered disk (if pressure displayed is too high). (Section 11.33.6, *Replacing the sintered disk and tank overpressure relief valve*, on page 11-210.) • Tank overpressure valve. (Section 11.33.6, *Replacing the sintered disk and tank overpressure relief valve*, on page 11-210.) • Sensor board. (See Section 11.31.4, *Replacing the sensor board*, on page 11-195.) **Note** If you replace an item and successfully repeat Unit 10.5, you must then perform all test software units again, starting with *1: Microprocessor checks*, on page 10-4.

Unit 10.6 Performing the tank overpressure-valve check

Perform all tasks marked with a grey background.

Field or Button	Function	Action	Check
Check mixer (button)	Enables you to check the safe operation of the tank's overpressure valve.	1. Activate the **Check mixer** button.	
Oxygen "knob" **Note** This field is displayed in the local language.	Enables you to select the concentration of oxygen delivered by the mixer to the tank. The tank is flushed until the required concentration is reached.	2. Activate the **Oxygen** "knob" and turn it to display **50** (50% oxygen). The tank is flushed with oxygen, and is pressurized until the tank overpressure valve opens.	
Ptank (field)	Displays the current tank pressure in millibars.		3. The value displayed must be less than **500**.

Troubleshooting the tank overpressure-valve check

Problem Area	Symptom	Action
Ptank (field)	Displays more than **500**.	• Remove the sintered sound absorber disc from the tank overpressure valve, to check whether it is blocking the flow. Replace if necessary. (See Section 11.33.6, *Replacing the sintered disk and tank overpressure relief valve*, on page 11-210.) • Replace the tank overpressure valve. (See Section 11.33.6, *Replacing the sintered disk and tank overpressure relief valve*, on page 11-210.)

Unit 10.7 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **Close**.

11: Flow Sensor circuit checks

Unit 11.1 Overview

This test unit enables you to check:

- The *Flow Sensor autozero valves*
- The *autorinse assembly*

Unit 11.2 Background information

In normal use, the Flow Sensor autozero valves stay closed for most of the time. This keeps both the small pneumatic connectors to the Flow Sensor airtight, and allows the *Flow Sensor differential-pressure sensor* inside GALILEO to compare pressures on either side of the Flow Sensor.

However, at calculated intervals during normal use (the exact times depend upon many factors) the two autozero valves open together, thereby bringing both sides of the Flow Sensor differential-pressure sensor to the same (ambient) pressure. This enables GALILEO to automatically perform a zero calibration of the sensor.

During this test software unit, the autozero valves continuously open for five seconds and then close for five seconds. When open, the pressure at the sensor drops to approximately zero. When the valves close, and ***when one Flow Sensor connector is blocked with a finger***, the pressure on one side of the sensor builds to a value determined by the rinse flow.

Pressure on one side of the differential-pressure sensor is measured as positive (with one Flow Sensor connector blocked), while pressure on the other side is measured as negative (with the other Flow

Sensor connector blocked). Figure 10-27 shows a very simplified view of the Flow Sensor connections inside GALILEO during this test.

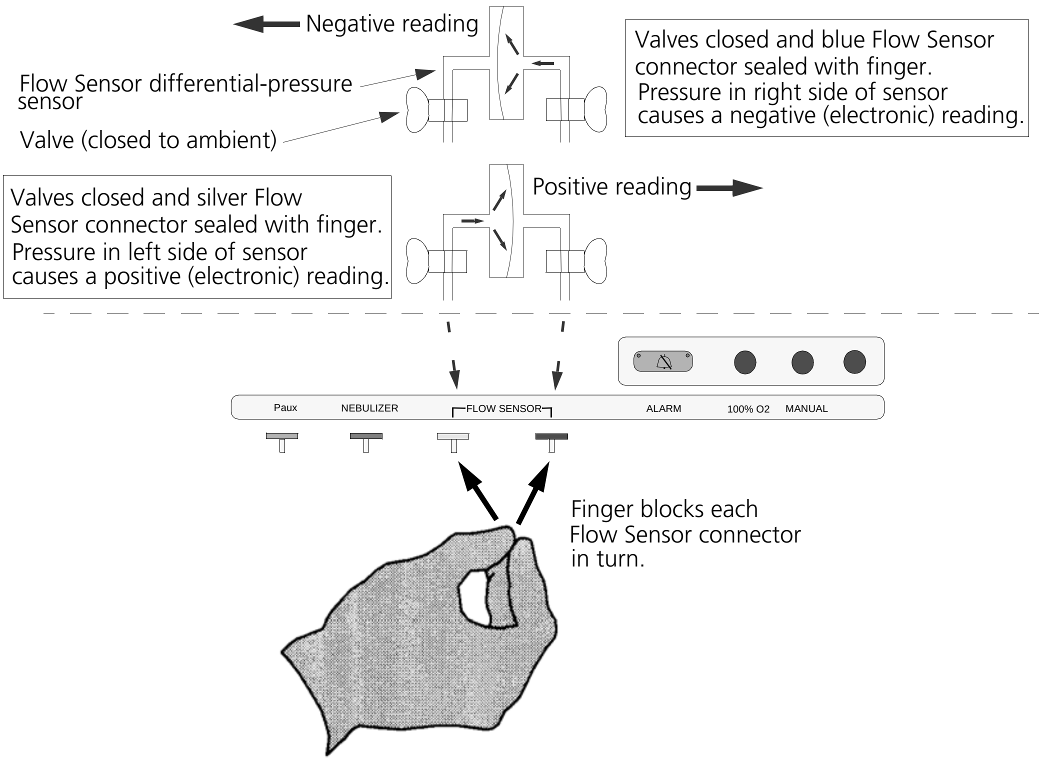


Figure 10-27. Positive and negative test readings at the Flow Sensor differential-pressure sensor

Unit 11.3 Preparation

Activate **`11: Flow Sensor circuit checks`**. The autozero valves begin a sequence of opening for five seconds and then closing for five seconds, and you see a display similar to the following:

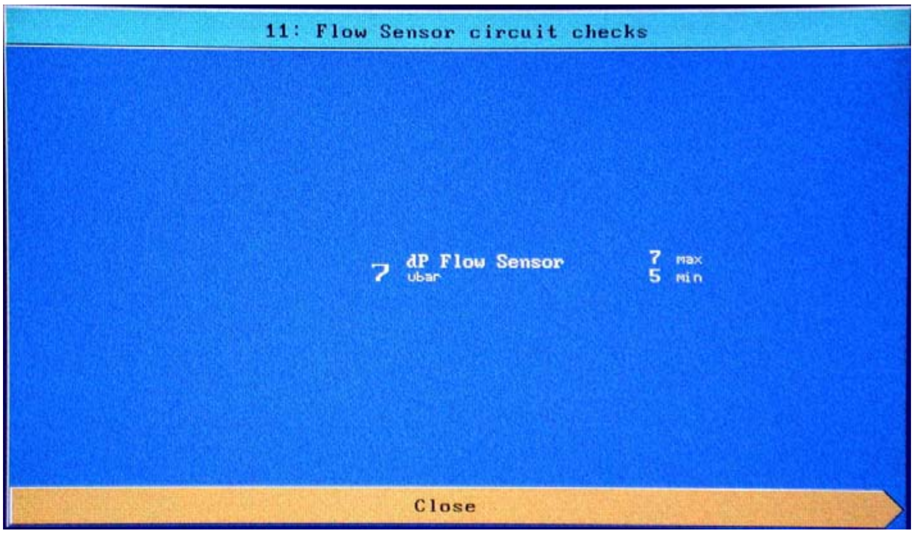


Figure 10-28. The `Flow Sensor circuit checks` screen

Unit 11.4 Performing the Flow-Sensor autozero-valve check

Perform all tasks marked with a grey background.

Field	Function	Action	Check
`dP Flow Sensor`	Displays the pressure at the Flow Sensor's differential pressure sensor. During this check, the pressure changes from approximately zero (when both sides of the Flow Sensor differential-pressure sensor are open to ambient pressure) to approximately 5000 (when one side of the Flow Sensor differential-pressure sensor is sealed, enabling the rinse flow to build pressure in that side).	**Note** It is permissible for intermediate values to be briefly displayed while GALILEO moves between the lowest and highest readings.	
		1. Seal the silver Flow Sensor connector with a finger. (Figure 10-29.)	2. Ensure that **`dP Flow Sensor`** alternates every five seconds between the following: • A value in the range **`-40`** to **`40`** • A value in the range **`5040`** to **`5200`**
		3. Seal the blue Flow Sensor connector with a finger.	4. Ensure that **`dP Flow Sensor`** alternates every five seconds between the following: • A value in the range **`-40`** to **`40`** • A value in the range **`-5040`** to **`-5200`**

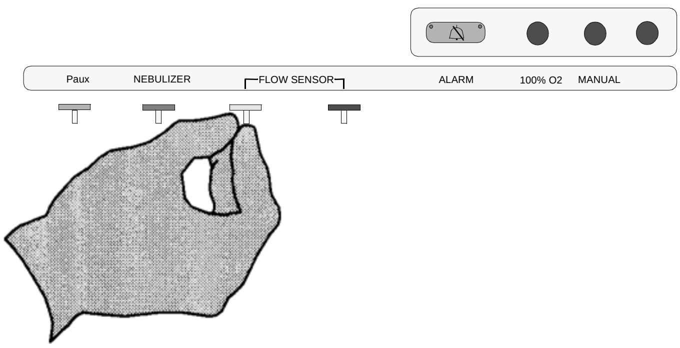


Figure 10-29. Sealing the silver Flow Sensor connector

Troubleshooting the Flow-Sensor autozero-valve check

Problem Area	Symptom	Action
`dP Flow Sensor`	Value out of range.	• Ensure that the autozero valves on the sensor board are properly connected without leaks. (See Section 2.3, *Components performing principle pressure and flow measurements*.) • Check for any other leaks. • If there are no leaks, try replacing the sensor board and repeating Unit 11.4. (See Section 11.31.4, *Replacing the sensor board*, on page 11-195.) **Note** If you replace the sensor board and successfully repeat Unit 11.4, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 11.5 Performing the rinse flow check

Ensure that the rinse flows through both of the small pneumatic connections to the Flow Sensor are equal. To do this:

1. Prepare two tubes of exactly equal length, approximately 15 cm long.
2. Attach one tube to the silver Flow Sensor connector, and one to the blue connector.
3. Place the ends of the tubes in a glass of water, as shown in Figure 10-30.

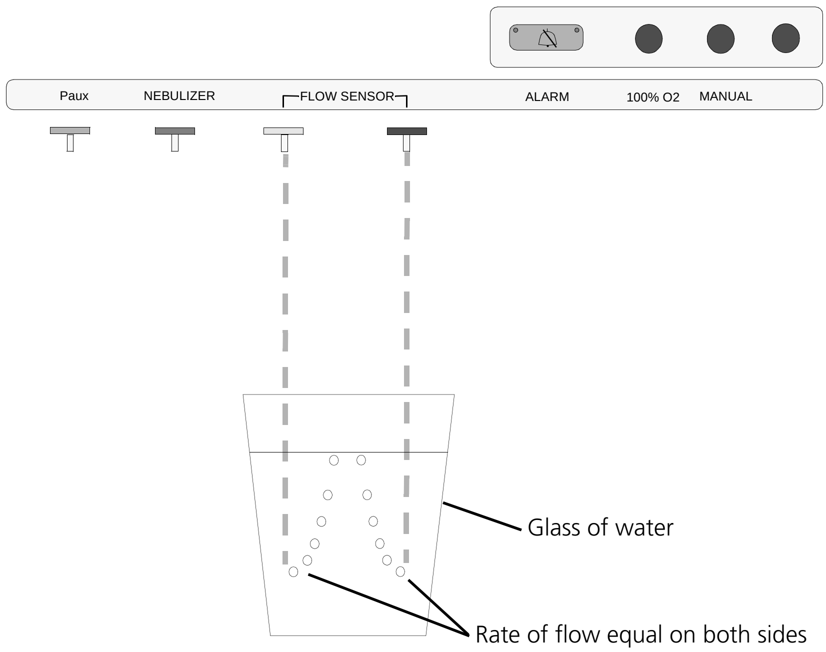


Figure 10-30. Checking the rinse flow rates

4. Ensure that the number of air bubbles appears almost exactly equal on both sides.

Troubleshooting the rinse flow check

Symptom	Action
Rate of flow is not equal on both sides.	• Ensure there is no air leak in the tubes or at the connectors.
There are no bubbles.	• Replace the Flow-Sensor rinse-flow sintered disk "pills" (flow restrictors). (See Section 11.32.6, *Managing tank connections and "pill" flow restrictors*, on page 11-201.)

Unit 11.6 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`**.

12: Patient overpressure valve checks

Unit 12.1 Overview

This test unit enables you to check:

- That the *inspiratory (servo) valve* is airtight
- That the *safety valve block* is airtight
- The pressure at which the *patient overpressure valve* opens

Unit 12.2 Preparation

Activate **`12: Patient overpressure valve checks`**. You see a display similar to the following:

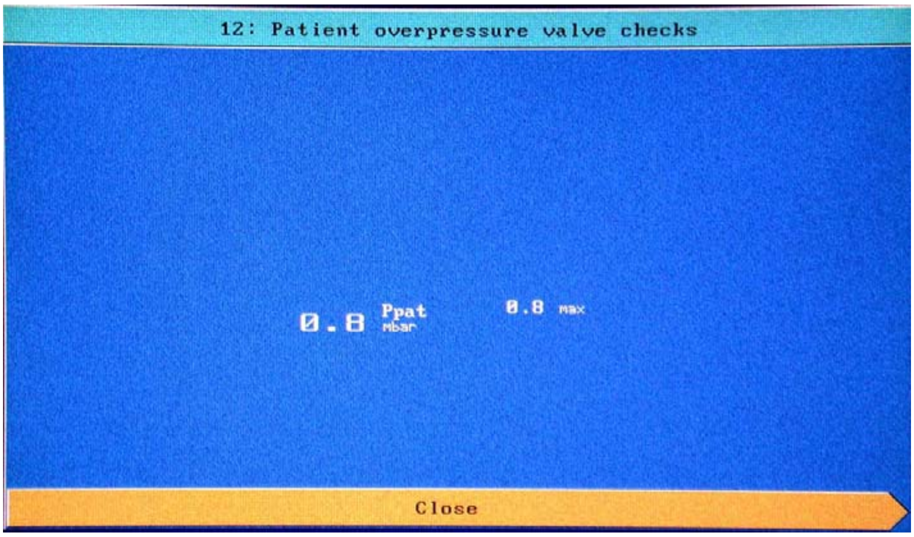


Figure 10-31. The `Patient overpressure valve checks` screen

Unit 12.3 Performing the inspiratory-valve airtightness check

1. Connect the 20 ml/s capillary tube and the pressure gauge as shown in Figure 10-32 below.

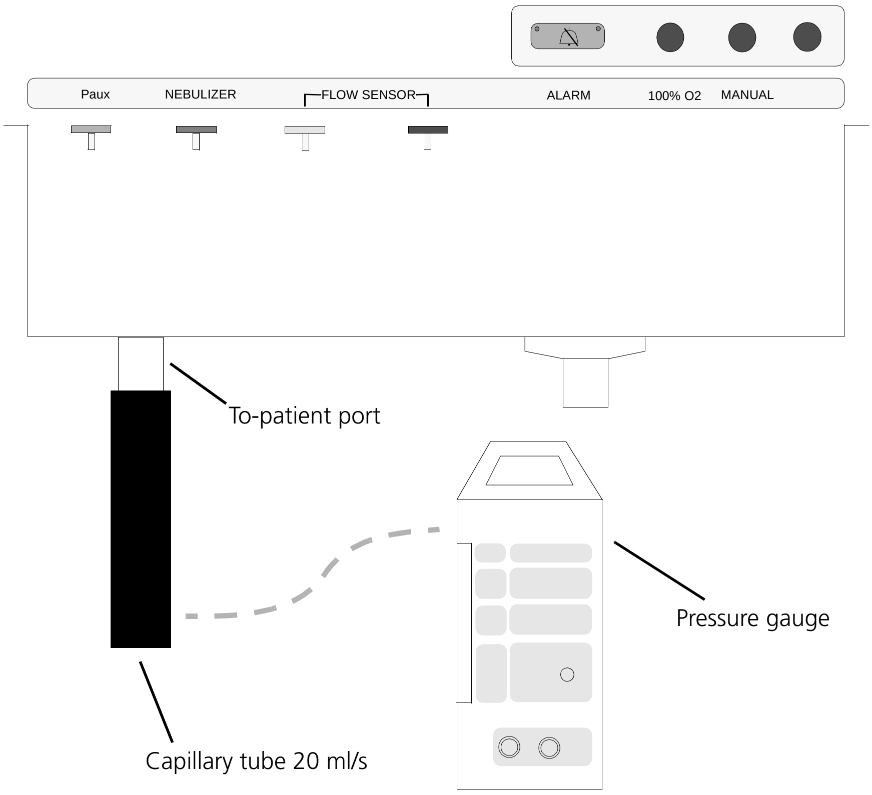


Figure 10-32. Setup for the inspiratory-valve airtightness check

2. Check that the pressure at the pressure gauge is as shown in Table 10-3.

Note
Leakage ranges depend upon the kind of inspiratory valve you have—old or new. You can read the part number on the label on top of the inspiratory valve.

Inspiratory valve PN 155161 (Old type)	Inspiratory valve PN 155491 (New type)
0 to 10 mbar	0 to 4 mbar

Table 10-3. Inspiratory-valve leakage values

Troubleshooting the inspiratory-valve airtightness check

Symptom	Action
Pressure gauge reads higher than 10 mbar with old type valve, or higher than 4 mbar with new type. (Leakage is too high.)	Try replacing the *inspiratory (servo) valve* and *servo board* module (see Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111) and repeating Unit 12.3. **Note** If you replace the servo module and successfully repeat Unit 12.3, you must then perform all test software units again, starting with *1: Microprocessor checks*, on page 10-4.

Unit 12.4 Performing the safety-valve-block airtightness check

1. Connect the tubing system as shown on Figure 10-33.

CAUTION

The connection between the hand pump and the GALILEO must have a volume of approximately 345 ml. The easiest way to achieve this is to connect the pump using a tube with a length of 110 cm and a diameter of 22 mm.

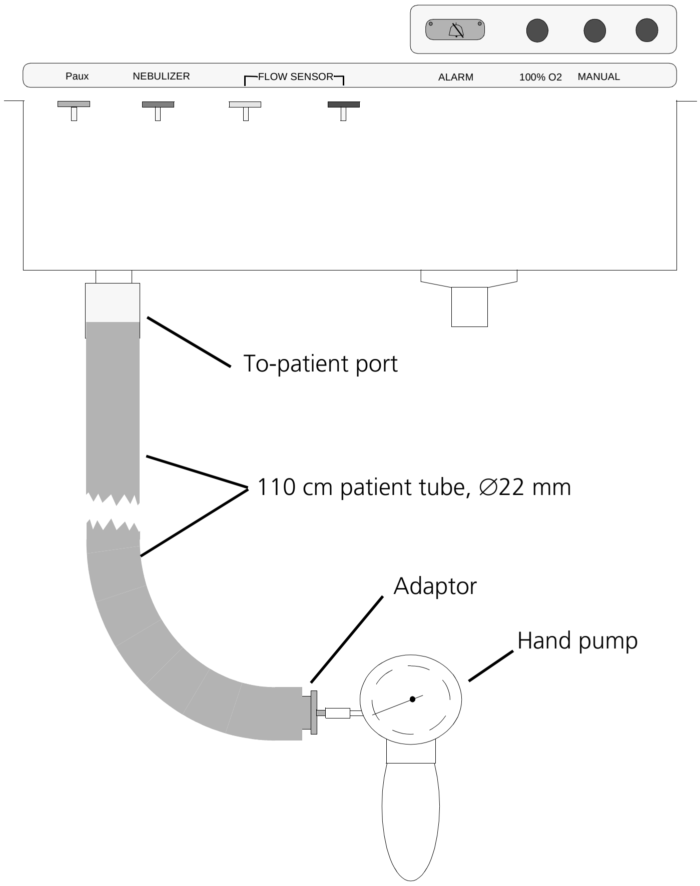


Figure 10-33. Setup for the safety-valve-block airtightness and patient overpressure-valve checks

2. Generate a pressure of 90 mbar with the hand pump.
3. Check that the time required for the pressure in the patient tube to decrease from 90 to 43 mbar is more than 10 seconds.

Troubleshooting the safety-valve-block airtightness check

Symptom	Action
Pressure in patient tube decreases too fast.	• Ensure there is no air leak in the patient tube or at the connectors. • Ensure there is no air leak in the tubes connecting to the *safety valve block*. (See Section 11.7, *Ambient valve and patient overpressure valve*, on page 11-19.) • Try replacing the *safety valve block* and repeating Unit 12.4. (See Section 11.7.5, *Maintaining and replacing the ambient and patient overpressure valves*, on page 11-22.) **Note** If you replace the safety valve block, you must repeat all test software units, starting with *1: Microprocessor checks*, on page 10-4.
Pressure in patient tube increases.	If there is an increase in pressure: • Check that the time for the pressure in the patient tube to increase from 50 to 97 mbar is more than 10 seconds. • If the time is less than 10 seconds, replace the inspiratory valve. **Note** If you replace the inspiratory valve, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 12.5 Performing the patient overpressure-valve check

1. Using the setup for the safety-valve-block airtightness check (Figure 10-33 on page 10-70), simulate an overpressure by continuously pumping the hand pump.
2. The overpressure valve must open and the pressure must drop (this can be clearly observed) when the pump reaches a pressure of between 104 and 116 mbar.

Troubleshooting the patient overpressure-valve check

Symptom	Action
Overpressure valve does not open in correct pressure range.	Replace the patient overpressure valve (see Section 11.7.5, *Maintaining and replacing the ambient and patient overpressure valves*, on page 11-22) and repeat Unit 12.5. **Note** If you replace the overpressure valve, and successfully repeat Unit 12.5, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 12.6 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`**.

13: Ambient valve check

Unit 13.1 Overview

This test unit enables you to check the *ambient valve*.

Unit 13.2 Preparation

1. Connect the patient tubing and your own personal bacteria filter as shown in Figure 10-34 below.

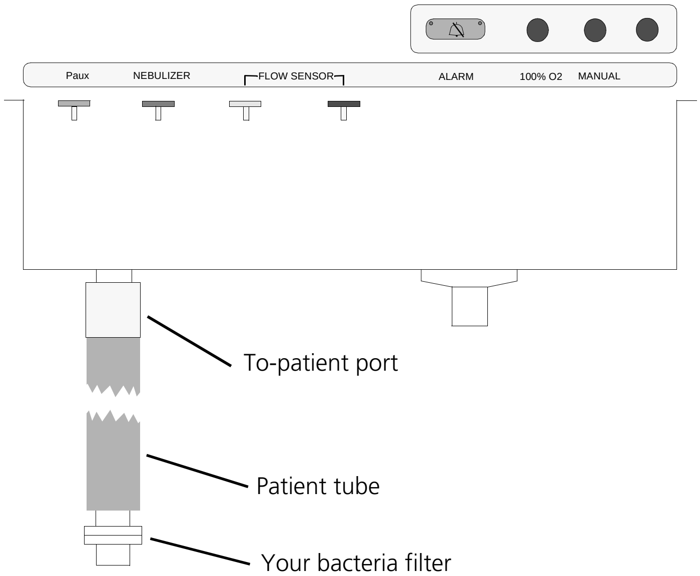


Figure 10-34. Tubing setup for the ambient valve check

2. Activate **`13: Ambient valve check`**. You see a display similar to the following:

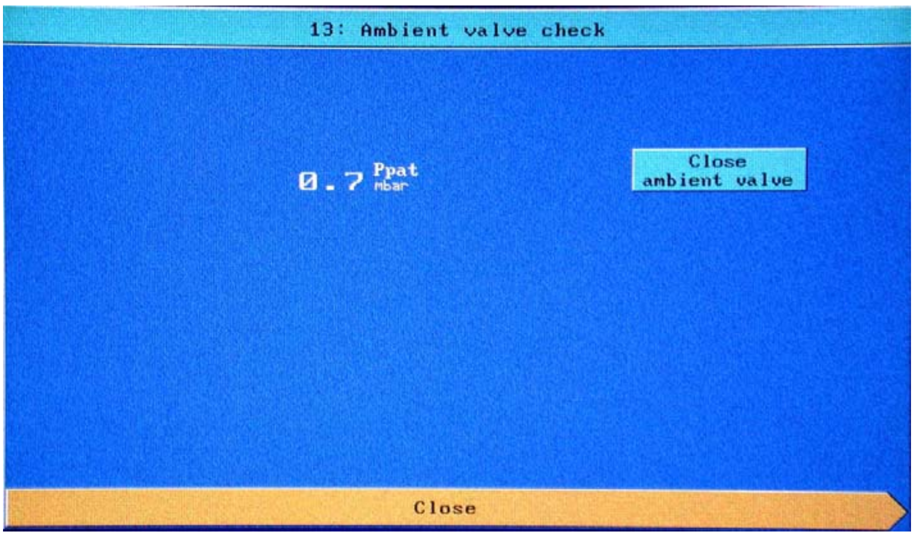


Figure 10-35. The `Ambient valve check` screen

Unit 13.3 Performing the ambient valve check

Perform all tasks marked with a grey background.

Buttons and Fields	Function	Action	Check
Ppat (field)	Displays patient pressure: a measurement of the pressure in the patient breathing circuit as measured at the inspiratory valve.	1. Inhale through the bacteria filter.	2. Ensure that it is possible to inhale, and that **Ppat** is in the range **0** to **-20** mbar.
		3. Try to exhale through the bacteria filter.	4. Ensure that it is not possible to exhale.
Close ambient valve (button)	Opens and closes the ambient valve.	1. Activate **Close ambient valve**.	
		2. Try to inhale and exhale through the bacteria filter.	3. Ensure that the ambient valve remains closed: you cannot inhale through the patient tubing.
		4. Deactivate **Close ambient valve**.	
		5. Inhale through the bacteria filter.	6. Ensure that the ambient valve remains open: you can inhale through the patient tubing.

Troubleshooting the ambient valve check

Problem Area	Symptom	Action
Ppat **Close ambient valve** (button)	Test fails.	• Ensure that all cables to the *safety valve block* and *control board* are correctly in place. • Try replacing each of the following items in turn, repeating Unit 13.3 after each replacement: • Solenoid. (See Section 11.7.5.1, *Replacing the ambient valve solenoid coil*, on page 11-22.) • Safety valve block. (See Section 11.7.5.2, *Replacing the safety valve block*, on page 11-24.) • The *connector board. (See* Section 11.10.6, *Replacing the connector board*, on page 11-40.) **Note** If you replace an item and successfully repeat Unit 13.3, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 13.4 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **Close**.

14: Inspiration valve check

Unit 14.1 Overview

This test unit enables you to check and, if necessary, to calibrate the delivery of air from the *inspiratory (servo) valve*, and to calibrate the *Flow Sensor*.

Note
This test calibrates the *Flow Sensor differential-pressure sensor* inside GALILEO, for the *Flow Sensor* currently fitted in the patient breathing circuit.

Unit 14.2 Background information

For this test unit you require a 20 ml/s capillary tube, and a 500 ml/s orifice tube. Each of these tubes is marked with two values:

- The nominal flow rate (20 or 500 ml/s)
- The pressure at which that flow rate is achieved (typically in the region of 50 to 70 mbar)

Note
You must compensate the readings you take with the 500 ml/s orifice tube, in accordance with Table 10-4 on page 10-77.

Unit 14.3 Preparation

1. Connect the 20 ml/s capillary tube and the pressure gauge as shown in Figure 10-36.

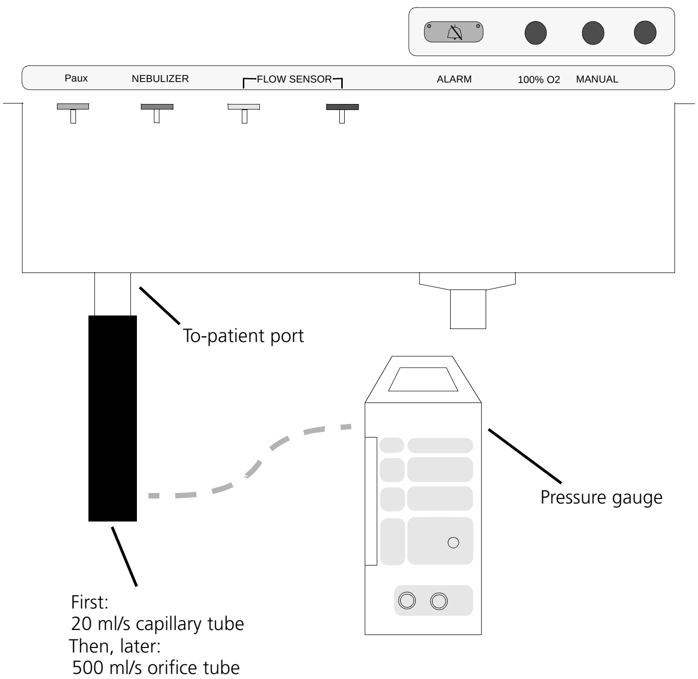


Figure 10-36. Setup for the inspiratory-valve air-delivery check

2. Activate **`14: Inspiration valve check`**. You see a display similar to the following:

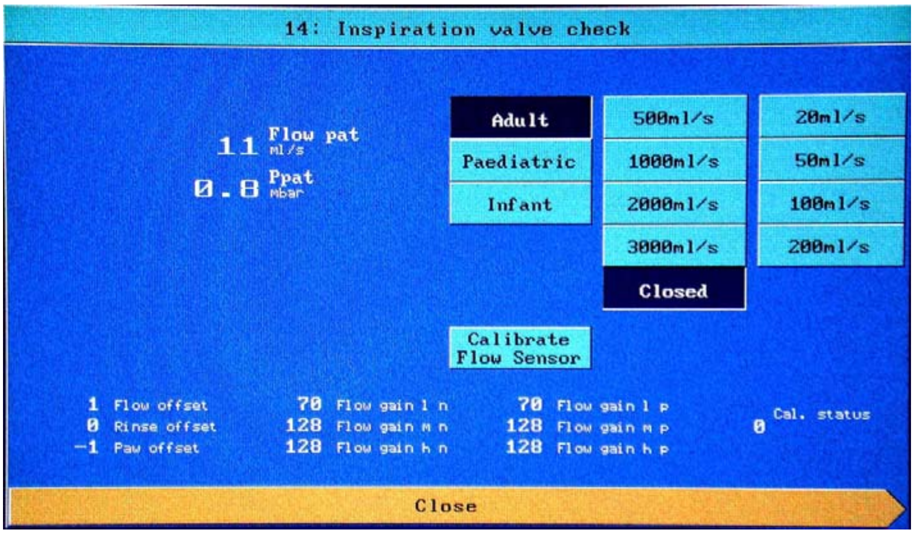


Figure 10-37. The `Inspiration valve check` screen

Unit 14.4 Performing the inspiratory-valve air-delivery check

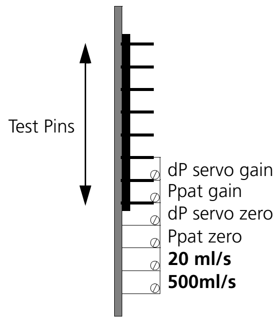
Perform all tasks marked with a grey background.

Button	Function	Action	Check
Adult	Prepares the GALILEO for an adult breathing circuit.	1. Activate `Adult`.	
`20ml/s`	Creates an airflow at the to-patient port of 20 milliliters per second.	2. Ensure the 20 ml/s capillary tube is connected, as shown in Figure 10-36 on page 10-75.	
		3. Activate `20ml/s`.	4. The pressure gauge must read the pressure marked on the capillary tube ±3 mbar.
		Note No altitude correction is required for the 20 ml/s capillary tube.	
`500ml/s`	Creates an airflow at the to-patient port of 500 milliliters per second.	1. Attach the 500 ml/s orifice tube, as shown in Figure 10-36 on page 10-75.	
		2. Activate `500ml/s`.	3. The pressure gauge must read the pressure marked on the orifice tube ±2 mbar.
		Note The 500 ml/s orifice tube was calibrated in Switzerland at 660 meters above mean sea level. If you are not at this altitude, you must apply a correction value according to Table 10-4 on page 10-77. For instance, if you are at 100 meters, you must add 3.6 mbars to the value shown on the pressure gauge.	

Altitude	0	50	100	150	200	250	300	350	400	450	500	550	600	650	660
Correction	+4.3	+4.0	+3.6	+3.3	+3.0	+2.7	+2.3	+2.0	+1.7	+1.4	+1.0	+0.7	+0.4	+0.1	0
Altitude	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100
Correction	-0.2	-0.9	1.5	-2.1	-2.7	-3.2	-3.8	-4.4	-5.0	-5.5	-6.1	-6.7	-7.2	-7.8	-8.4

Table 10-4. Altitude correction values for 500 ml/s orifice tube

Troubleshooting the inspiratory-valve air-delivery check

Problem Area	Symptom	Action
20ml/s (button) **500ml/s** (button)	Pressure gauge is out of range during check.	Calibrate the inspiratory valve. To do this: 1. Attach the 20 ml/s capillary tube and the pressure gauge. 2. Activate **20ml/s**. 3. Adjust potentiometer 20 ml/s on the servo board until the pressure is within range. (Shown below, and in more detail in Figure 10-15 on page 10-35.) 4. Attach the 500 ml/s orifice tube and the pressure gauge. 5. Activate **500ml/s**. 6. Adjust potentiometer 500 ml/s on the servo board. (Shown below, and in more detail in Figure 10-15 on page 10-35, and Table 10-4 on page 10-77.) 7. Repeat steps (1) to (6) until both readings are in range.  **Note** The adjustment of one potentiometer affects the adjustment of the other. For this reason you must repeat the adjustments as often as required until both pressure readings are in range.
	Calibration does not bring pressure gauge into range.	Replace the inspiratory valve module (see Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111) and repeat Unit 14.4. **Note** If you replace the inspiratory valve module and successfully repeat Unit 14.4, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 14.5 Performing the Flow Sensor calibration

1. Connect a patient breathing circuit with a Flow Sensor but without a test lung. (The *GALILEO Intensive Care Ventilator Operator's Manual* has a diagram showing a suitable setup.)
2. Perform the following actions and checks:

Buttons and Fields	Function	Action	Check
Adult	Prepares the GALILEO for an adult breathing circuit and Flow Sensor.	Activate **Adult** if you are using an adult breathing circuit and Flow Sensor.	None.
Paediatric	Prepares the GALILEO for a pediatric breathing circuit and Flow Sensor.	Activate **Paediatric** if you are using an pediatric breathing circuit and Flow Sensor.	
Infant	Prepares the GALILEO for an infant breathing circuit and Flow Sensor.	Activate **Infant** if you are using an infant breathing circuit and Flow Sensor.	
Calibrate Flow Sensor (button)	Starts the calibration of the Flow Sensor.	1. Activate **Calibrate Flow Sensor**. 2. Follow the instructions on the screen, removing, turning, and replacing the Flow Sensor as instructed.	3. The screen must display **Flow Sensor is calibrated** (or your local language equivalent) at the end of calibration.
Cal. status (field)	Displays the status of the calibration process. All values except **0** indicate that the process is running. The value **0** indicates that the process is complete. **Note** The value **0** does not necessarily indicate a successful calibration.		4. **Cal. status** must display **0** at the end of calibration.

Troubleshooting the Flow Sensor calibration

Problem Area	Symptom	Action
Calibration fails	The message **`Flow Sensor is calibrated`** (or your local language equivalent) is not displayed at the same time that **`Cal. status`** displays **`0`**.	• Repeat the calibration—it is possible you made a mistake in handling or turning the Flow Sensor. • Ensure that you are using a breathing circuit and Flow Sensor of the correct type for the button you activated: **`Adult`**, **`Paediatric`** or **`Infant`**. • Check all external tubing for leaks. • Try replacing each of the following items in turn, repeating Unit 14.5 after each replacement: • The Flow Sensor. • The *inspiratory (servo) valve* module. (See Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111.) • The *sensor board*. (See Section 11.31.4, *Replacing the sensor board*, on page 11-195.) **Note** If you replace the sensor board and successfully repeat Unit 14.5, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 14.6 Performing the inspiratory-valve linearity check

1. Leave the patient tubing in place.
2. Perform the following actions and checks:

Buttons and Fields	Function	Action	Check
20ml/s **50ml/s** **100ml/s** **200ml/s** **500ml/s** **1000ml/s** Closed	Create an airflow at the to-patient port of 20, 50, 100... milliliters per second.	1. Activate 20ml/s. 2. Make sure that **Flow pat** is in the range shown on Table 10-5. 3. Make sure that **Ppat** is in the range shown on Table 10-5. 4. Repeat procedure for other buttons. **Note** Do not use the **2000ml/s** and **3000ml/s** buttons. It is only possible to attain a peak (not a constant) flow with these buttons.	
Flow pat (field)	Displays the flow to the patient in milliliters per second, as measured at the inspiratory valve.		As detailed in the grey section above, **Flow pat** values must always be in the range shown on Table 10-5.
Ppat (field)	Displays patient pressure: a measurement of the pressure in the patient breathing circuit as measured at the inspiratory valve.		As detailed in the grey section above, **Ppat** values must always be in the range shown on Table 10-5.

Buttons	**Flow pat**	**Ppat**
20ml/s	**0** to **40**	**0** to **5**
50ml/s	**30** to **70**	**0** to **5**
100ml/s	**80** to **120**	**0** to **5**
200ml/s	**160** to **240**	**0** to **5**
500ml/s	**425** to **575**	**0** to **5**
1000ml/s	**850** to **1150**	**0** to **10**
Closed	**0** to **5**	**0** to **5**

Table 10-5. Flow pat and Ppat values

Troubleshooting the inspiratory-valve check

Problem Area	Symptom	Action
`Flow pat` `Ppat`	One or more values are out of range.	Try replacing each of the following items in turn, repeating Unit 14.6 after each replacement: • *Flow Sensor* • The *inspiratory (servo) valve* and *servo board* module. (See Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111.) • The *sensor board*. (See Section 11.31.4, *Replacing the sensor board*, on page 11-195.) **Note** If you replace an item and successfully repeat Unit 14.6, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 14.7 Completing this unit

1. Do not remove the patient tubing.
2. Fill in the results of this test unit in your test report.
3. Activate **`Close`**.

15: Expiration valve calibrat. & check

Unit 15.1 Overview

This test unit enables you to calibrate and check the *expiratory valve*.

Unit 15.2 Preparation

Activate **`15: Expiration valve calibrat. & check`**. You see a display similar to the following:

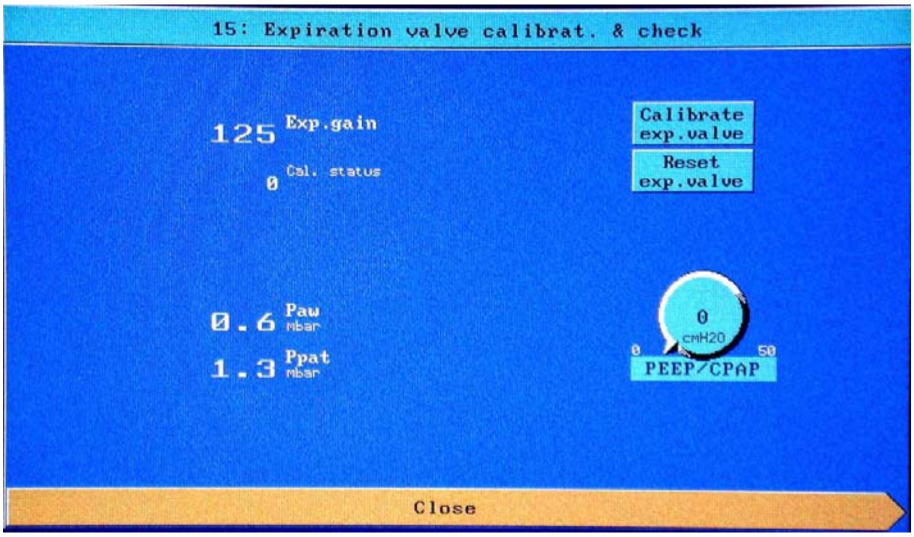


Figure 10-38. The `Expiration valve calibrat. & check` screen

Unit 15.3 Performing the expiratory valve calibration

1. Seal the open end of the Flow Sensor with a finger or thumb, so that the patient breathing circuit is completely enclosed. (Figure 10-39.)

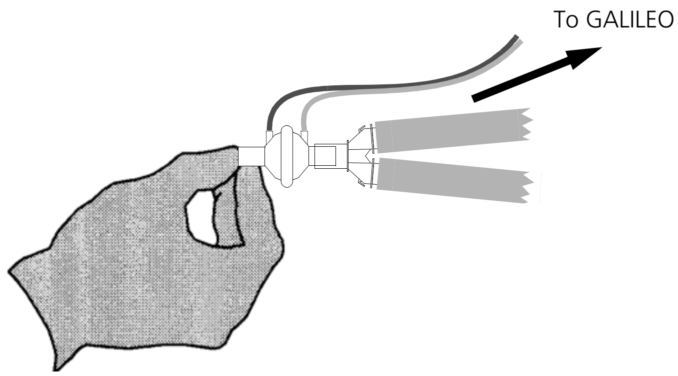


Figure 10-39. Sealing the Flow Sensor

2. Perform the following actions and checks:

Buttons and Fields	Function	Action	Check
`Exp. gain` (field)	Displays the gain applied to the analog signal controlling the *expiratory valve*. Calibrating the expiratory valve adjusts this value.	None.	None.
`Reset exp. valve` (button)	Resets the value of **`Exp. gain`** to the factory setting of 128. (This makes later calibration easier, as calibration begins with the **`Exp. gain`** approximately correct.)	1. Activate **`Reset exp. valve`**.	
Calibrate exp. valve (button)	Starts the expiratory valve calibration procedure.	2. Activate **`Calibrate exp. valve`**.	3. The screen must display **`Exp. Valve Cal. ok`** after a short time, at the end of the calibration procedure.
`Cal. status` (field)	Displays the status of the calibration process. The value **`26`** indicates that the process is running. The value **`0`** indicates that the process is complete. **Note** The value **`0`** does not necessarily indicate a successful calibration.		4. **`Cal. status`** must display **`0`** at the end of calibration.

Troubleshooting the expiratory valve calibration

Problem Area	Symptom	Action
Expiratory valve calibration	The message **`Exp. Valve Cal. ok`** is not displayed at the same time that **`Cal. status`** displays **`0`**.	• Check the cables going to the *expiratory valve*. • Check the cables going to the *connector board*. • Check the patient tubing system for leaks. • Check that air and oxygen supplies are connected properly. • Clean the expiratory valve plunger pin. • Try replacing each of the following items in turn, repeating Unit 15.3 after each replacement: • The *expiratory valve* cover. • The expiratory valve membrane. (See Section 11.13.6, *Replacing the expiratory valve positioning coil*, on page 11-67.) • The patient tubing system. • The *connector board*. *(See* Section 11.10.6, *Replacing the connector board*, on page 11-40.) • The *expiratory valve*. *(See* Section 11.13.6, *Replacing the expiratory valve positioning coil*, on page 11-67.) **Note** If you replace an item and successfully repeat Unit 15.3, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.

Unit 15.4 Performing the expiratory valve linearity check

Perform all tasks marked with a grey background.

Note
Keep the seal on the Flow Sensor.

"Knob" and Fields	Function	Action	Check
PEEP/CPAP "knob"	Sets the lowest pressure that is ever permitted in the patient breathing circuit.	1. Activate the **PEEP/CPAP** "knob" with the control knob in the normal way. 2. Turn the **PEEP/CPAP** "knob" so that it displays **0**. Perform the **Paw** and **Ppat** checks for **PEEP/CPAP** "knob" **0**. (Table 10-6 on page 10-86.) 3. Repeat for values of **5**, **10** and **30**. (Table 10-6 on page 10-86.)	
Paw	Displays the patient airway pressure.		As detailed in the grey section above, **Paw** must display the values shown on Table 10-6 on page 10-86.
Ppat	Displays patient pressure: a measurement of the pressure in the patient breathing circuit as measured at the inspiratory valve.		As detailed in the grey section above, **Ppat** must display the values shown on Table 10-6 on page 10-86.

PEEP/CPAP setting	**Paw**	**Ppat**
0	**0** to **1.5**	
5	**4.0** to **6.5**	
10	**9.0** to **11.5**	
30	**28.5** to **32**	

Table 10-6. Paw and Ppat values

Troubleshooting the expiratory valve linearity check

<table>
<tr><th>Problem Area</th><th>Symptom</th><th>Action</th></tr>
<tr><td><code>Paw</code></td><td rowspan="2">Values out of range.</td><td rowspan="2">Try replacing each of the following items in turn, repeating Unit 15.4 after each replacement:
• The expiratory valve cover. (See Section 11.13.6, Replacing the expiratory valve positioning coil, on page 11-67.)
• The expiratory valve membrane. (See Section 11.13.6, Replacing the expiratory valve positioning coil, on page 11-67.)
• The expiratory valve. (See Section 11.13.6, Replacing the expiratory valve positioning coil, on page 11-67.)

Note
If you replace an item and successfully repeat Unit 15.4, you must then perform all test software units, starting with 1: Microprocessor checks, on page 10-4.</td></tr>
<tr><td><code>Ppat</code></td></tr>
</table>

Unit 15.5 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **`Close`**.

16: Nebulizer compressor check

Unit 16.1 Overview

This test unit enables you to check the compressor and valve that provide air for an optional nebulizer.

Unit 16.2 Background

As a part of this test unit, you will check that the nebulizer valve switches off the flow of gas to the nebulizer compressor.

To do this, you will first disconnect the nebulizer valve electronically, and then measure the flow of gas delivered by the nebulizer. With the valve not functioning, the flow of gas from the nebulizer should be very small.

Because your test equipment does not include a flow meter to measure the gas flow directly, you will measure it indirectly, by timing the pressure increase of the gas delivered by the nebulizer into a vessel of fixed volume.

To perform this test unit, you therefore require a watch with a seconds display to use as a timing device.

Unit 16.3 Preparation

Activate **`16: Nebulizer compressor check`**. You see a display similar to the following:

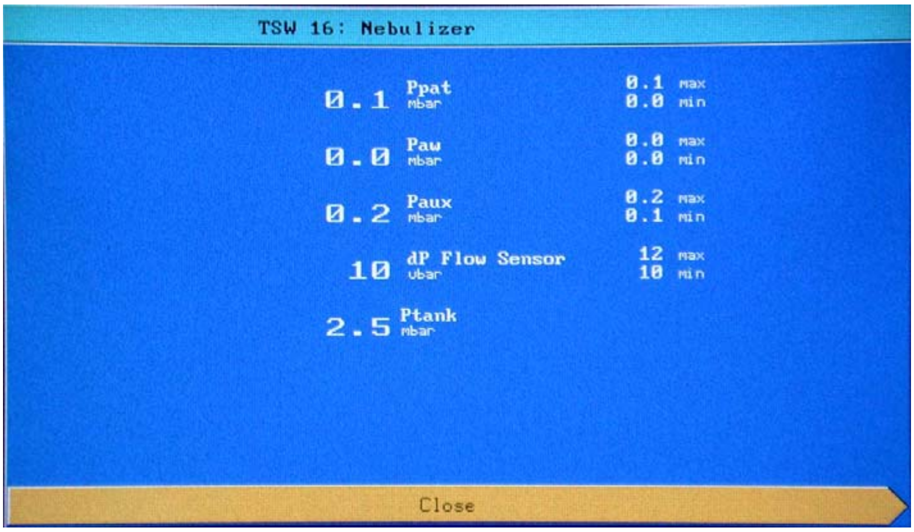


Figure 10-40. The `Nebulizer compressor check` screen

Unit 16.4 Performing the nebulizer compressor and valve checks

1. To check that the nebulizer valve switches off the flow of gas to the nebulizer compressor, do the following:
   a. Ensure that the nebulizer valve remains closed during the check, by temporarily disconnecting it from the connector board, as shown in Figure 10-41.

Note
It is acceptable to feel some blowing/sucking at the nebulizer connector when the nebulizer valve is closed.

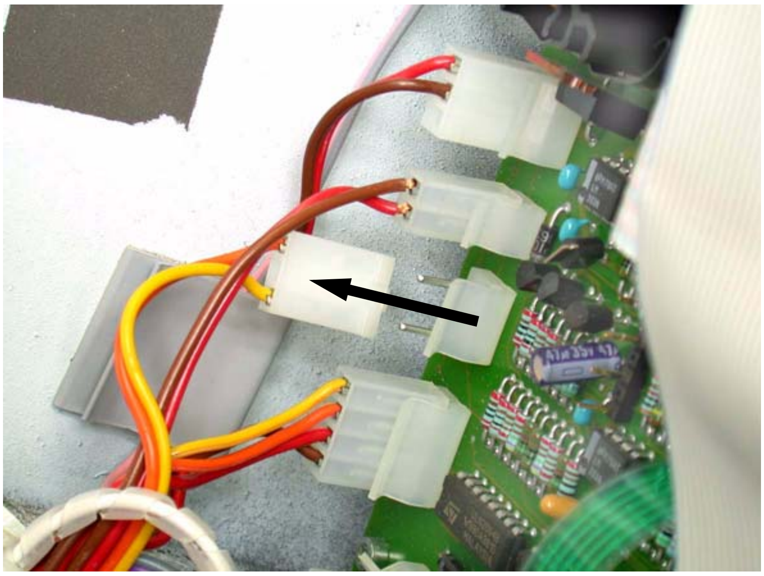


Figure 10-41. The nebulizer valve connector temporarily disconnected from the connector board

b. Construct a vessel of 630 ml volume by using two lengths of 110 cm patient tubing, as shown in Figure 10-42.
Notice that the auxiliary pressure (Paux) and nebulizer connectors are connected.

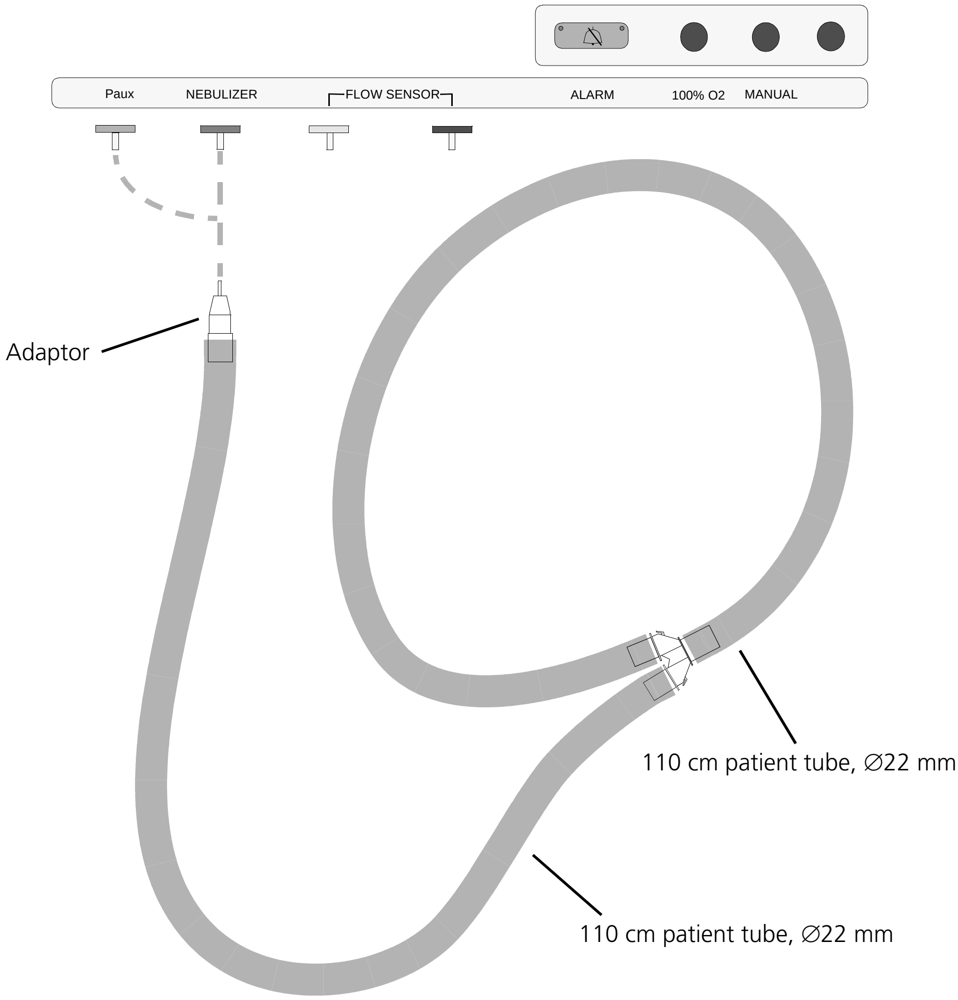


Figure 10-42. Setup for testing the nebulizer valve in the closed position

c. With GALILEO running, and the nebulizer valve still (electronically) disconnected, perform the following check:

Field	Function	Action	Check
Paux	Displays the pressure at the auxiliary pressure connector.	1. Disconnect a part of the tubing setup, to release any pressure in the patient tubing. 2. Wait until the nebulizer motor stops and then restarts, and reconnect the tubing.	
		3. Wait exactly 10 s while the nebulizer pumps gas into the patient tubing.	4. **`Paux`** must display less than **`35.0`** after 10 s.

d. Reconnect the nebulizer to the connector board. (This is a reversal of Figure 10-41.)

2. Connect the pressure gauge to the nebulizer connector as shown in Figure 10-43, using a pressure probe suitable for measuring about 2000 mbar.

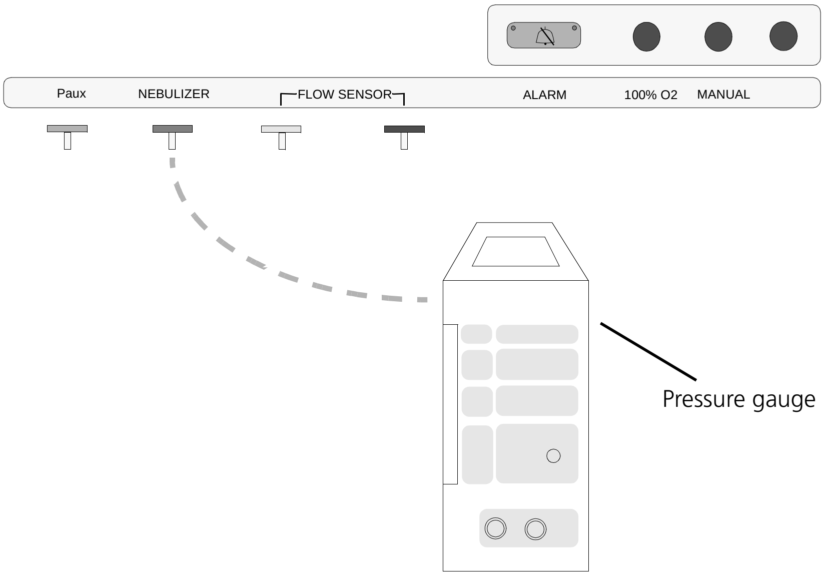


Figure 10-43. Setup for checking the nebulizer compressor and valve

a. Check that:
- The nebulizer valve repeatedly turns on for five seconds, and then off for five seconds. (This is shown by the pressure gauge.)
- The nebulizer compressor stops for 10 seconds after every 30 seconds. (The noise from the compressor stops completely.)

Figure 10-44 gives a graphical representation of this activity.

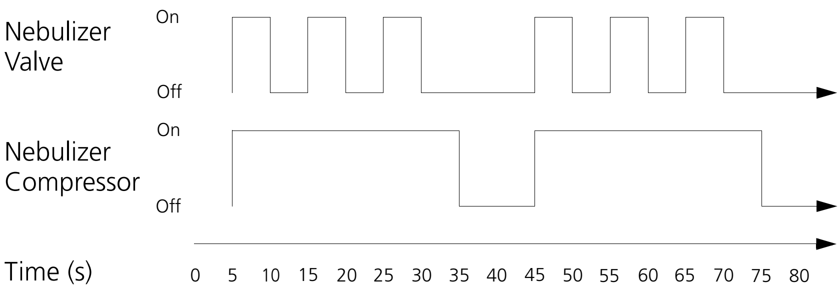


Figure 10-44. Nebulizer valve and compressor activity check

b. Check that when the nebulizer valve is open and the compressor is running, the pressure at the gauge is greater than 800 mbar.

3. Perform the following check:

Field	Function	Action	Check
`Ptank`	Displays the pressure in the tank. (The nebulizer compressor takes its gas supply from the tank.)	None.	`Ptank` must display `150` to `350`.

Troubleshooting the nebulizer compressor and valve checks

Problem Area	Symptom	Action
Paux	Pressure rises to more than **35.0** after 10 s during nebulizer valve test.	• Ensure that there is no leak into the nebulizer pump at the gas inlet (the tubing coming from the nebulizer valve to the top of the nebulizer pump). (See Section 11.26, *Nebulizer compressor and solenoid valve*, on page 11-150.) • Try replacing the nebulizer valve on the back of the nebulizer and repeating Unit 16.4. (Section 11.26.6, *Maintaining or replacing the nebulizer compressor and solenoid valve*, on page 11-153.) **Note** If you replace the nebulizer valve and successfully repeat Unit 16.4, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.
Pressure at pressure gauge	Pressure lower than 800 mbar when nebulizer running, and nebulizer valve open.	Try replacing each of the following items in turn, repeating Unit 16.4 after each replacement: • *Nebulizer solenoid valve. (See* Section 11.26.6, *Maintaining or replacing the nebulizer compressor and solenoid valve*, on page 11-153.*)* • Nebulizer compressor membrane. *(See* Section 11.26.6, *Maintaining or replacing the nebulizer compressor and solenoid valve*, on page 11-153.*)* • Nebulizer compressor. *(See* Section 11.26.6, *Maintaining or replacing the nebulizer compressor and solenoid valve*, on page 11-153.*)* **Note** If you replace an item and successfully repeat Unit 16.4, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.
Nebulizer valve and compressor timing	Nebulizer valve and compressor do not switch on and off as shown in Figure 10-44, *Nebulizer valve and compressor activity check*.	• *Verify that the cables from the nebulizer compressor and the nebulizer valve to the control board are properly in place, then repeat* Unit 16.4. • Try replacing the *control board, then repeating* Unit 16.4. **Note** If you replace an item and successfully repeat Unit 16.4, you must then perform all test software units, starting with *1: Microprocessor checks*, on page 10-4.
Ptank	Pressure is not **150** to **350**.	Repeat Unit 10.3, *Performing the tank leakage check*, on page 10-56.

Unit 16.5 Completing this unit

1. Fill in the results of this test unit in your test report.
2. Activate **Close** (or the local language equivalent).

Note

You have now completed all the tests available in GALILEO's test mode. *17: Event log check & export*, on page 10-94 is not a test; it enables you to read the event log.

---

3. As directed in Section 4.4, *Procedure*, on page 4-3:
   a. Lock all the potentiometer adjustment screws in place using proprietary locking paint or nail varnish.
   b. Close and screw shut the GALILEO.
   c. Perform the following tests, as described in the *GALILEO Intensive Care Ventilator Operator's Manual*:
      - Preoperational check
      - 3-month check

17: Event log check & export

Unit 17.1 Overview

This unit enables you to:

- View the event log
- Export the event log to a CompactFlash data carrier

Note

- This unit does not include any tests. You do not need to run this unit when performing the other tests in the test software.
- You can only export the event log if your GALILEO is prepared for accessing a second CompactFlash, and you have a suitable second CompactFlash in place. (See Unit 17.2.5, *Notes on exporting events*, on page 10-97.)

Unit 17.2 Background information

Unit 17.2.1 Purpose of the event log

The event log keeps a record of most activity in GALILEO. Amongst other reasons, you might access the event log to:

- Trace the history of events leading up to a catastrophic patient incident
- Precisely inform HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch) of a technical problem

Unit 17.2.2 Event log memory management

Unless a GALILEO is new or has had very little use, the event log always holds a minimum of 4,000 events. When the memory limit is reached, the older half of the events is deleted, and the freed area of memory is used again to record the latest events. The complete memory area is never deleted.

Note

Switching off and on GALILEO does not delete memory.

Unit 17.2.3 Structure of an event

As shown in Figure 10-47, *Viewing the event log*, on page 10-99, an event comprises:

- Date and time
- Class (described in Table 10-7 on page 10-95)
- General description
- ID (identifier)

Together, the ID and the class uniquely identify an event. This combination is of particular value in communicating with HAMILTON MEDICAL AG technical support when a GALILEO is not using the English or German language setting.

Event class	Explanation
`Alarms`	Record the occurrence (but not clearance) of all high-, medium-, and some low-priority patient alarms.
`Calibration`	Record any calibration. For instance: • Flow Sensor • Oxygen cell • Tightness test (this is classed as a calibration) • Expiratory valve (these calibrations can only be performed in test mode)
`Device`	Record instrument-related information such as configuration, serial numbers and revision numbers.
Overflow	Records an intermediate buffer overflow. This occurs when too many events take place in the current session for all to be recorded. (However, you can probably record further events in later sessions.)
`Power`	Record the time the GALILEO was switched on.
`Setting`	Record all control settings, such as: • Mode changes • Ventilation parameters • Alarm limits • Patient group
`Special`	Record measurements such as: • PV Tool • Inspiratory or expiratory Hold • Oxygen flush • Standby • Mandatory breath • Nebulizer
`Supply`	Record supply alarms: • Power supply • Air supply • Oxygen supply
`Tech. fault`	Record technical events and technical faults. • Technical events have numbers TF 80–2999. These are ***not*** shown on the LCD display during operation. They are also ***not*** displayed on screen when viewing the event log. They refer to exception handling performed by GALILEO during operation, and are for HAMILTON MEDICAL AG internal use. Do not consult HAMILTON MEDICAL AG technical support concerning these technical events. They are have no significance for hospital workers or field engineers. • Technical faults have numbers TF 5500 and higher. These describe problems with the GALILEO that require intervention. They are shown on the LCD display during normal operation. For more information, see Section 12.2, *Troubleshooting using technical faults*, on page 12-2 and the following sections.
`Test mode`	Record the performing of each unit in the test mode by an engineer.

Table 10-7. Event classes

Unit 17.2.4 Accessing the event log

You can access events in three ways:

- By viewing events on the LCD display when in normal ventilation mode.
  To do this, you select the Event Log symbol from the monitoring menu, as explained in GALILEO's operators' guide. You see only the subset events that are allowed by the filter **`Clinical`**. (Table 10-8.)
- By viewing events on the LCD display when in this unit (Unit 17).
  To do this, you select any one of a range of filters to display a subset of events. (Table 10-8.)
- By downloading events to a CompactFlash data carrier.
  You can see all events by using a card reader. For more information, see Unit 17.2.5, *Notes on exporting events*, on page 10-97.

Event classes			Filters					
			Accessible in normal ventilation mode	Accessible from Unit 17 in software version 3.1*				
				Accessible from Unit 17 in software version 3.3*				
Name	**Color**	**Language**	**`Clinical`**	**`All`[a]**	**`Technical`**	**`Alarms`**	**`Configuration`**	**`User`**
`Alarms`	High: Red Medium: Orange Low: Orange	As set for user interface	✓	✓		✓		
`Calibration`	White	As set for user interface	✓	✓	✓			✓
`Device`	Green	English		✓	✓		✓	
`Overflow`	White	As set for user interface	✓	✓	✓	✓	✓	✓
`Power`	White	As set for user interface	✓	✓	✓	✓		✓
`Setting`	White	As set for user interface	✓	✓				✓
`Special`	White	As set for user interface	✓	✓				✓
`Supply`	Red	As set for user interface	✓	✓	✓	✓		
`Tech. fault`[b] (TF 5500 and higher)	Red	English	✓	✓	✓	✓		
`Test mode`	Green	English		✓	✓		✓	

Table 10-8. Dividing events into groups by applying filters

a. Despite its name, this filter does not display technical events. You can only see technical events by downloading the event log, as described in Unit 17.5, *Exporting the event log*, on page 10-100.
b. To see technical events (TF 80 to 4499) you must download the event log, as described in Unit 17.5, *Exporting the event log*, on page 10-100.

Unit 17.2.5 Notes on exporting events

When you export events, you send all events to a CompactFlash.

However, you can only export the event log if:

- A CompactFlash specially preformatted by HAMILTON MEDICAL AG (PN 155537) is inserted in the second (right-hand) card slot of the control board. (Figure 11-48 and Figure 11-49 on page 11-48 show the placement of the data CompactFlash.)
- Your GALILEO is configured to recognize a second CompactFlash.

Configuring GALILEO to recognize a second CompactFlash means setting up the CMOS to access a second hard disk interface. If your GALILEO was upgraded in the field, this is probably not yet done. If you want to find out if your GALILEO is configured in this way, do the following:

1. Place a HAMILTON MEDICAL AG preformatted CompactFlash (PN 155537) in the second (right-hand) card slot of the control board.
2. Start GALILEO in test mode, and go to *17: Event log check & export*, on page 10-94.

   If you see the message, **`No data-CompactFlash (#2) detected!`** your GALILEO is not configured for a CompactFlash card.

For assistance in configuring the CMOS for the second CompactFlash, contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

After exporting the event log, remove the CompactFlash and do any of the following:

- Send the CompactFlash to HAMILTON MEDICAL AG for analysis.
- Read the file **`event.txt`** on the CompactFlash by placing the CompactFlash in a suitable card reader connected to a computer running an ASCII editor.
- Read the file **`event.txt`** as above, and e-mail it to HAMILTON MEDICAL AG for analysis.

Unit 17.3 Preparation

Activate **`17: Event log check & export`**. You see a display similar to Figure 10-45 or Figure 10-46.

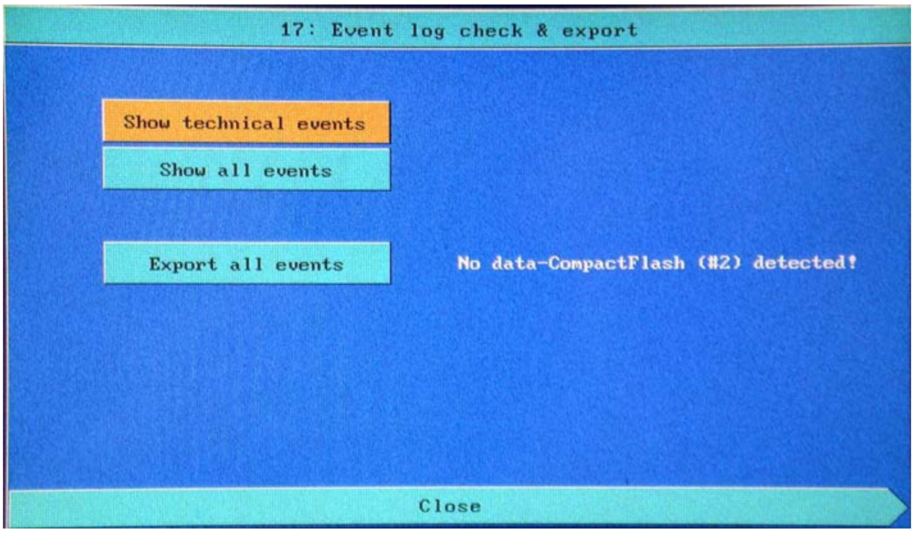


Figure 10-45. The `Event log check & export` screen (GMP 03.1* software)

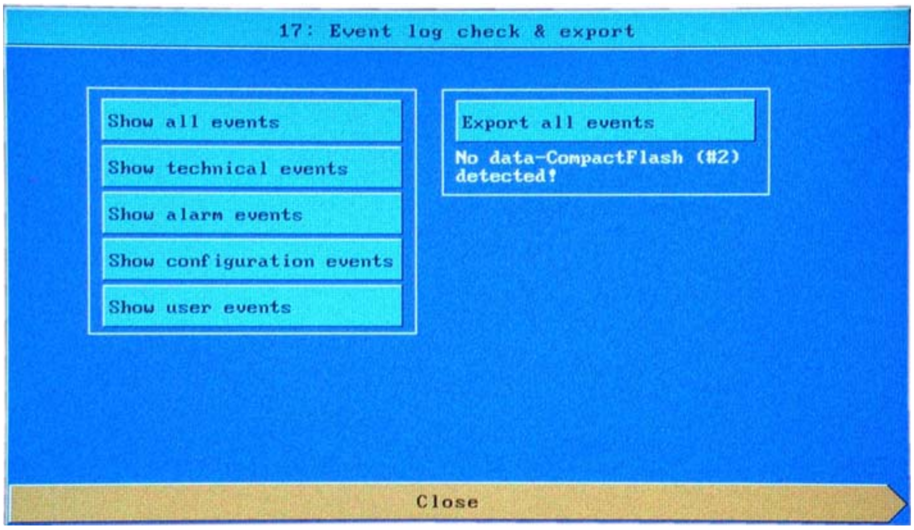


Figure 10-46. The `Event log check & export` screen (GMP 03.3* software)

You probably see the status message **`No data-CompactFlash (#2) detected!`** This informs you that there is no suitable CompactFlash in place for downloading the event log to, or, if there is a CompactFlash in place, GALILEO is not configured to communicate with it. (For more information, see Unit 17.2.5, *Notes on exporting events*, on page 10-97.)

Unit 17.4 Viewing the event log

When you view the event log on the screen, you can display “all” events (events of “all” classes) or you can apply a filter to view only a subset containing events of one or several event classes. Table 10-7 on page 10-95 explains event classes. Table 10-8 on page 10-96 shows the relationship between filters and event classes.

Note
When you select the **`All`** filter, you do not display technical events (TF 80 to 4499).

To view events, activate one of the **`Show...`** buttons.

You see a screen similar to that shown on Figure 10-47.

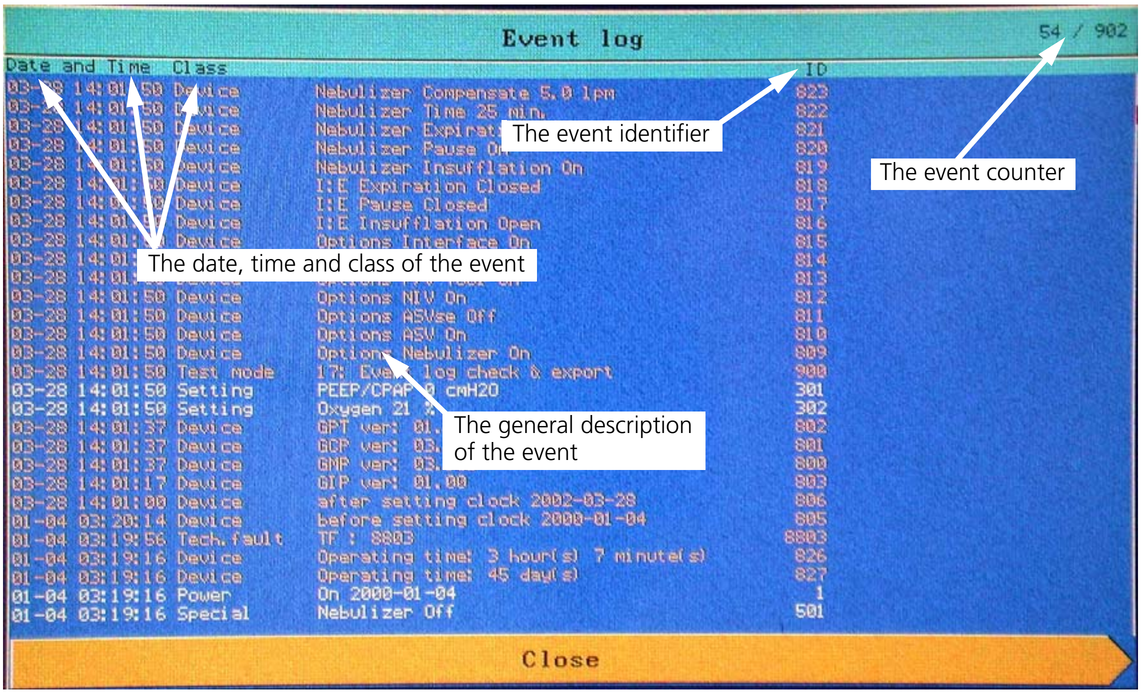


Figure 10-47. Viewing the event log

GALILEO displays events with the most recent at the top. Usually, there are too many events to fit on the screen. To see events not currently displayed, scroll the screen by turning the control knob clockwise.

Each event comprises Date, Time, Class, a general description, and ID. (For more information about this, see Unit 17.2.3, *Structure of an event*, on page 10-94.)

At the top right of the screen is the event counter. This displays:

- The number of the event displayed at the top of the screen.
  When the screen first opens, this is always Event 1. However, in our example, it is Event 54 because the screen has been scrolled.
- The number of the last event in the log.
  In our example, this is Event 902. The last event is usually only displayed on the screen if you scroll down to see it. You cannot see the last event in our example.

Unit 17.5 Exporting the event log

1. Ensure there is a HAMILTON MEDICAL AG preformatted CompactFlash card in the second (right-hand) slot of the *control board*, and that your CMOS is suitably configured. (See Unit 17.2.5, *Notes on exporting events*, on page 10-97.)

Note
The status message **`Data-CompactFlash (#2) ready`** must be displayed.

2. Activate **`Export all events`**, and wait for the message **`Export done`**.
3. Remove the CompactFlash card, and deal with it as required. (See Unit 17.2.5, *Notes on exporting events*, on page 10-97.)

Troubleshooting exporting the event log

Symptom	Action
The following message is displayed: **`No data-CompactFlash (#2) detected!`**	• Ensure there is a CompactFlash in the second (right-hand) slot of the control board, and that it is properly inserted. (Section 11.11, *Control board and GMP assembly*, on page 11-45.) • Ensure the CompactFlash is preformatted by HAMILTON MEDICAL AG, and is PN 155537. • Ensure that the CMOS setup is prepared for accessing a second CompactFlash (GALILEO units that were upgraded in the field to Upgrade 2 are not normally suitably configured). Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch) for more details.
The following message is displayed at the bottom of the screen: **`Export failed!`**	• Ensure the CompactFlash data carrier is not full. • If the message **`No data-CompactFlash (#2) detected!`** is also displayed, perform the actions in the table cell above.

Part 3:
Component details, repairs, and troubleshooting

Section
11 Component details and replacement procedures

WARNING
You must perform the repairs detailed in this section only as instructed in Section 4, *Overview of preventive maintenance and testing*.

11.1 Overview

This section gives:

- General information about all major components in GALILEO
- Maintenance or replacement information about many components

For information about gas flows between components, see Section 2, *Pneumatics: components and theory of operation*.

11.2 Notes on maintenance and replacement

HAMILTON MEDICAL AG does not permit repairs to most components in GALILEO. For example:

- You must replace the *inspiratory (servo) valve* as a complete module, including *servo board*.
- You must replace the *expiratory valve* as a complete assembly.
- You must replace the *tank overpressure valve* as a complete assembly.
- You must replace all printed circuit boards.

Always make sure that all grounding (earthing) connections are in place, especially after replacing any component. These connections are of two sorts:

- The contact strips between the front and rear upper enclosures. (Figure 11-2 on page 11-5.)
- The many green/brown wires that are connected to the chassis and the inside of the column.

During maintenance or replacement, it is sometimes possible to break a cable grip. Although these grips are not critical components, HAMILTON MEDICAL AG recommends that any broken grip be replaced, and that users keep a supply of these low-cost items. For more information, see Appendix H.12, *Cable grips*, on page H-14.

Note
Never attempt to repair a printed circuit board. Always send faulty boards back to HAMILTON MEDICAL.

CAUTION

- Make sure to take full ESD (electrostatic discharge) precautions before opening GALILEO. For more information see Appendix A.3.5, *ESD protection*, on page A-3.
- When GALILEO is switched on, even when not connected to the external mains power supply, the backup batteries supply power. It is therefore possible to cause a short circuit at a point distant from the backup batteries when GALILEO is switched on.
- Always disconnect GALILEO from the external mains power supply, and turn GALILEO off, before replacing any component.
- Always make sure that all grounding (earthing) connections are in place.

WARNING

- **Always disconnect the GALILEO from the external mains power supply before removing the cover from the column.**
- **Never use any kind of lubrication on any part of GALILEO.**

11.3 Contents of this section

11.4 Opening the main enclosure

Note
Only open GALILEO's main enclosure if instructed to in a later section.

1. Take the full ESD (electrostatic discharge) precautions shown in Appendix A.3.5, *ESD protection*, on page A-3.
2. Remove from GALILEO:
   - External mains power supply
   - Air and oxygen supplies
   - Patient breathing circuit (for convenience only)
   - Flow Sensor tubes (for convenience only)
3. Remove the four hexagonal-drive (Allen) screws at the rear of the enclosure. Figure 11-1 shows where two screws were removed from the right side of the enclosure.

Figure 11-1. Positions of the screws securing the main enclosure

4. Tip the front of the enclosure forward to expose the interior.

WARNING

While maintaining or replacing components inside the main enclosure, do not touch the contact strips (Figure 11-2) as the sharp edges could result in injury.

Figure 11-2. Contact strips

11.5 Opening the column

Note
Only perform this procedure if instructed to do so in a later section.

1. Take the full ESD (electrostatic discharge) precautions shown in Appendix A.3.5, *ESD protection*, on page A-3.
2. Remove from GALILEO:
   - External mains power supply
   - Air and oxygen supplies
   - Patient breathing circuit (for convenience only)
   - Flow Sensor tubes (for convenience only)
3. Loosen the rear panel of the column by removing the six hexagonal-drive (Allen) screws that hold it in place (Figure 11-3).

Figure 11-3. Positions of the screws securing the rear panel on the column

4. Without removing any electrical connections, open the left side of the column as wide as practical. This exposes:
    - GALILEO's internal power supply (Figure 11-4)
    - The battery fuse (Figure 11-4)
    - The diagnostic LEDs on the power supply's main circuit board (Figure 11-4)
    - The backup batteries (Figure 11-5)

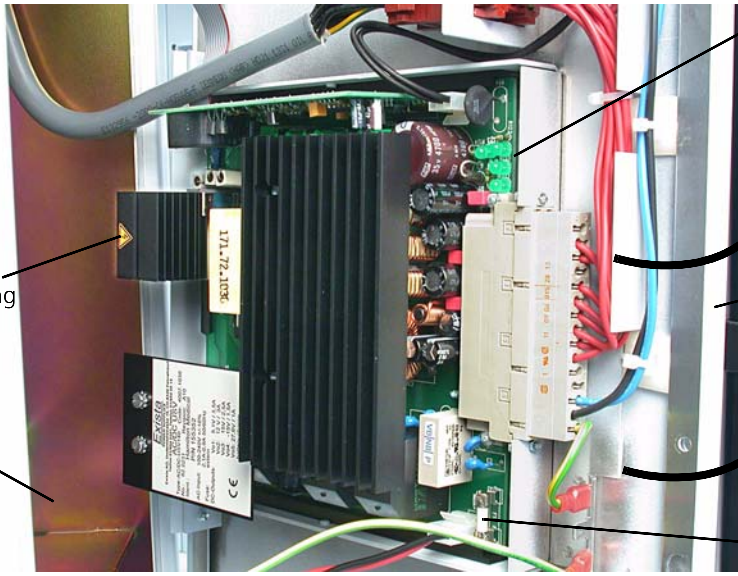


Figure 11-4. The open panel displaying the power supply

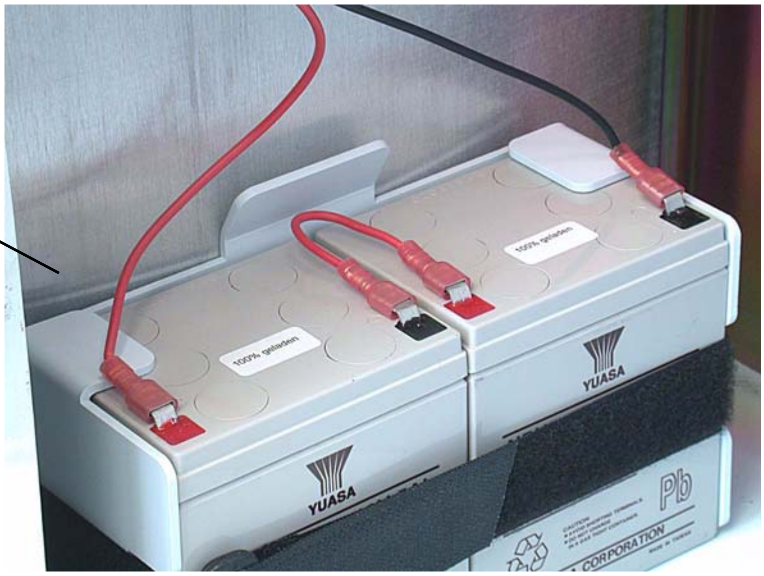


Figure 11-5. The 12 V backup batteries in the column

5. Make sure that no electrical connections are touching the column.
6. Make sure that all green/brown grounding (earthing) cables are securely in place.

11.6 Opening the shelf mount

Note
Only perform this procedure if instructed to do so in a later section.

11.6.1 Preparation

1. Take the full ESD (electrostatic discharge) precautions shown in Appendix A.3.5, *ESD protection*, on page A-3.
2. Remove from GALILEO:
   - External mains power supply
   - Air and oxygen supplies
   - Patient breathing circuit
   - Flow Sensor tubes

11.6.2 Dismantling GALILEO

Note
This job requires two people.

1. Remove the four hexagonal-drive (Allen) screws securing the top panel to the battery and power-supply container. (Figure 11-6.)

Figure 11-6. **Removing the four screws securing the top panel**

2. Remove the top panel, pulling the earth connector free as you do so. (Figure 11-7.)

CAUTION

It is easy to break the contact strip mounted on the top panel.

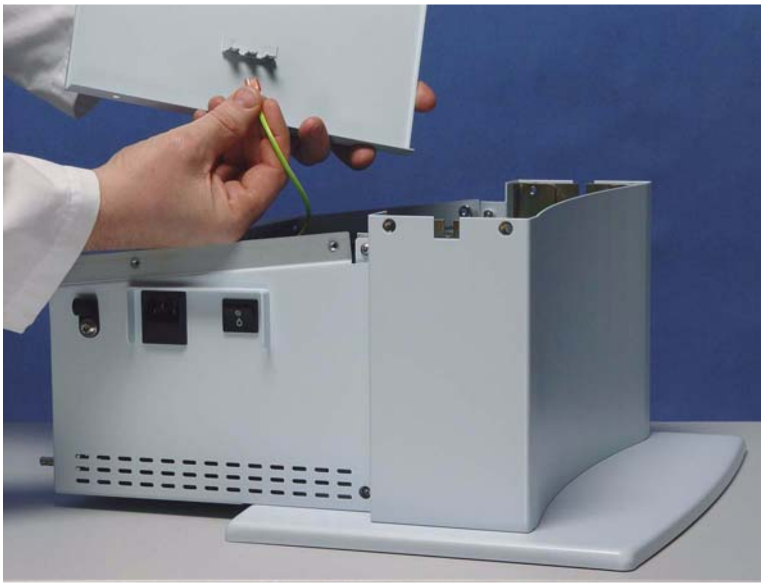


Figure 11-7. Removing the earth connector from the top panel

3. Supporting the power supply with one hand, remove the two hexagonal-drive (Allen) screws and washers that secure the power supply to the base of the shelf mount. (Figure 11-8.)

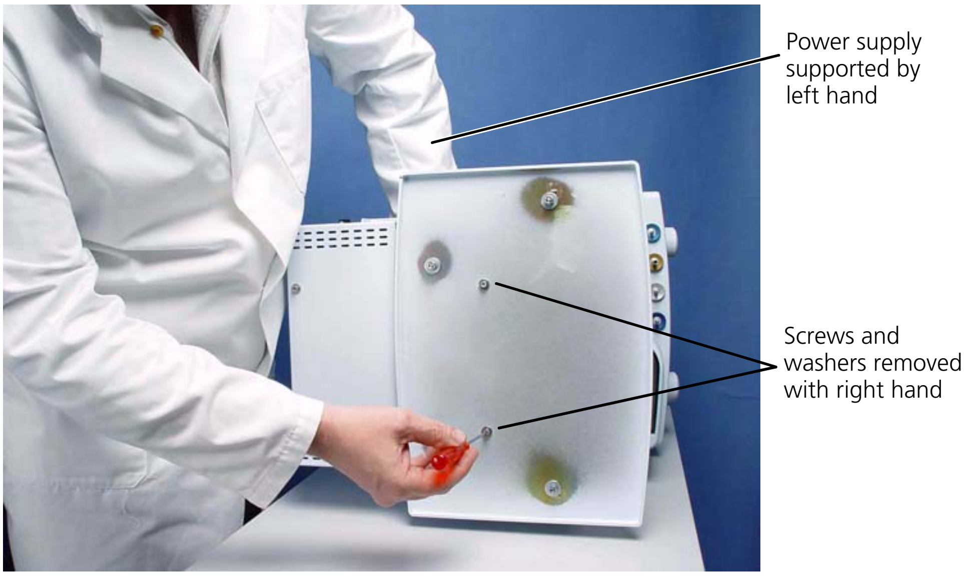


Figure 11-8. Removing the screws securing the power supply to the base

4. Remove the four hexagonal-drive (Allen) screws securing the battery and power-supply container to the column. (Figure 11-9.)

Figure 11-9. Removing the four hexagonal-drive (Allen) screws

5. Slide the power supply and battery container away from the column (Figure 11-10).

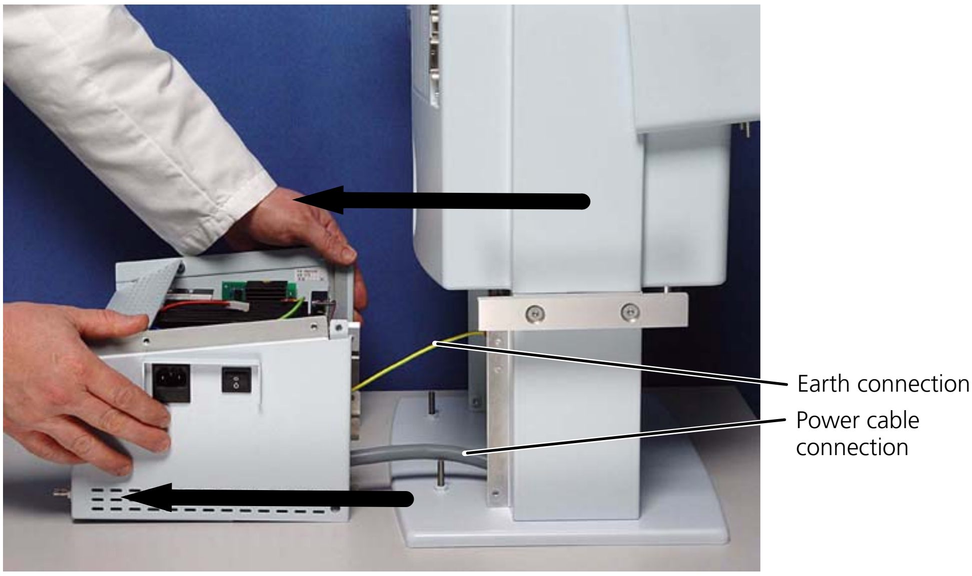


Figure 11-10. Sliding the power supply away from the column

6. Pull the earth connector free from the column. (Figure 11-11.)

CAUTION

It is easy to break the contact strip mounted in the column.

Figure 11-11. Pulling the earth connector free

7. Locate the power cable socket on the power supply board. (Figure 11-12.)

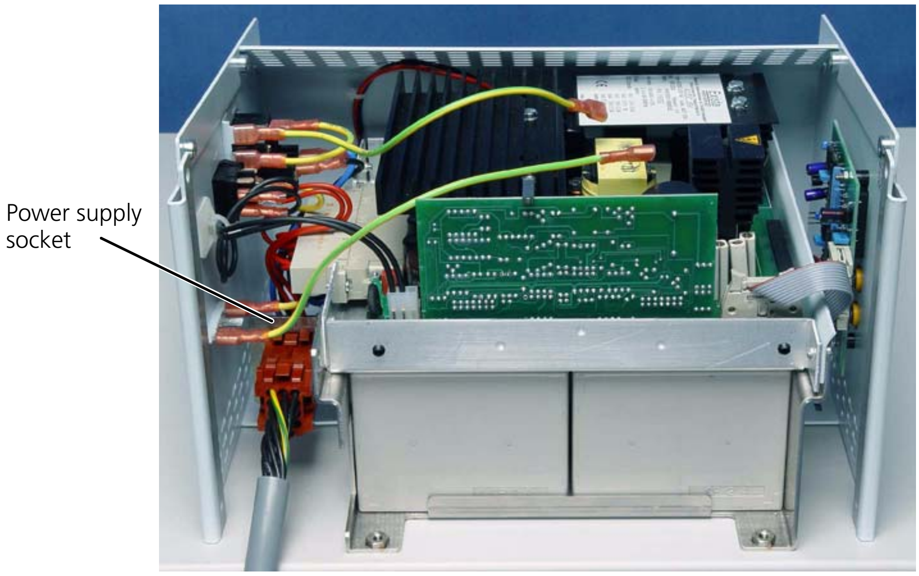


Figure 11-12. Location of power cable socket on power supply board

8. Remove the plug on the power cable from the socket on the power supply.

Note
This job requires two people.

The first person squeezes the two locking tabs on the socket, using his forefingers, working from underneath the power supply box.

The second person pulls the plug free.

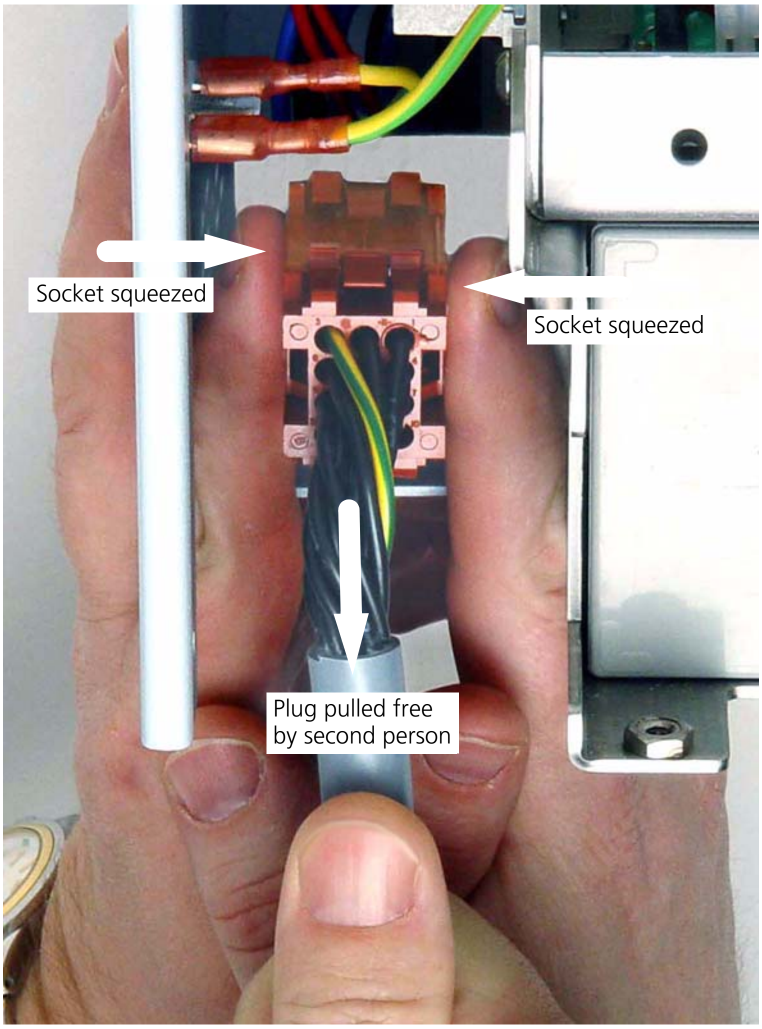


Figure 11-13. The removing the power cable plug from its socket

11.6.3 Removing the power supply from its container

1. Remove the two hexagonal-drive (Allen) screws and washers securing the power supply to its container. (Figure 11-14.)

CAUTION

Keep the power supply and battery container level, and perform this job from underneath. This lessens the chance of the released power supply unit from causing damage to contacts and switches mounted in the container.

Screws and washers

Figure 11-14. Releasing the power supply from its container

2. Remove all electrical connections to the power supply at the places indicated on Figure 11-15:
   - 1: Power supply board to indicator board, ribbon cable.
   - 2: External mains power to power supply board.
   - 3: Power supply container to GALILEO column, earth connection. (Already disconnected from GALILEO.)
   - 4: Power supply container to power supply socket, earth connection.
   - 5: Mains power switch to power supply socket. (2 connected cables.)
   - 6: Power supply container to power supply board, earth connection. (The lowermost connector.)
   - 7: External power supply socket to power supply board. (2 cables. Note colors before removing.)

Figure 11-15. Power supply connections

3. Using extreme care, separate the power rear cover, power supply/chassis, and the GALILEO housing. (Figure 11-16.)

CAUTION

It is easy to damage the indicator board during this procedure.

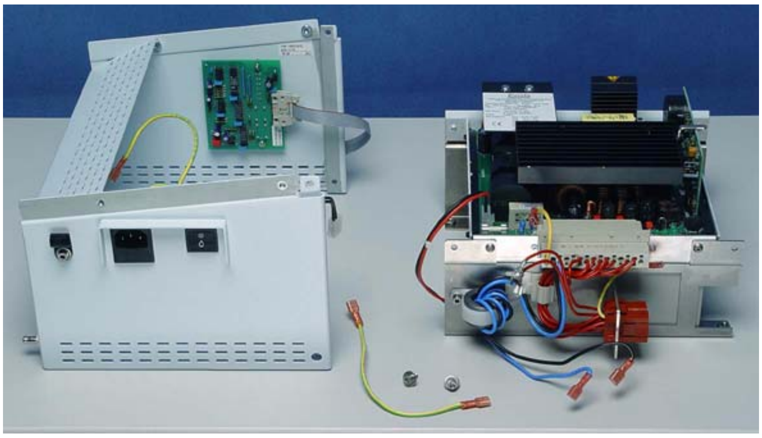


Figure 11-16. The separated container and power supply

4. Remove the battery connector from the power supply board. The board is now isolated from the 12 V backup batteries.

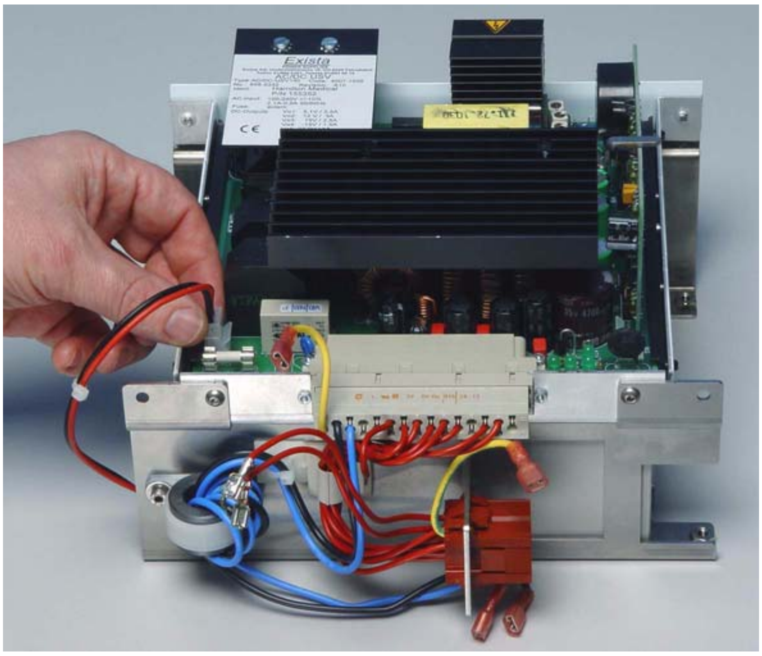


Figure 11-17. Removing the battery cable from the power supply

5. Remove the two hexagonal-drive (Allen) screws securing the power supply board mounting plate to the main chassis. (Figure 11-18.)

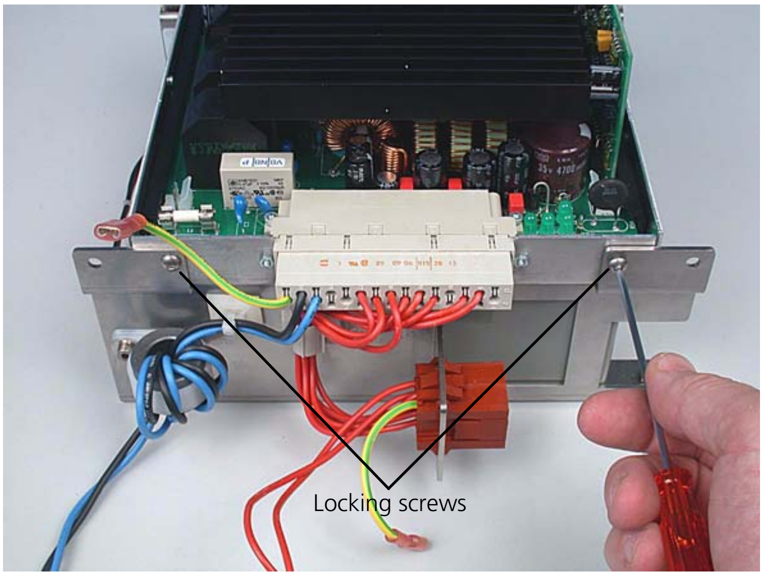


Figure 11-18. Removing the mounting plate screws

6. Turn the power supply around, and remove the two hexagonal-drive (Allen) screws securing the power supply board locking bar. (Figure 11-19.)

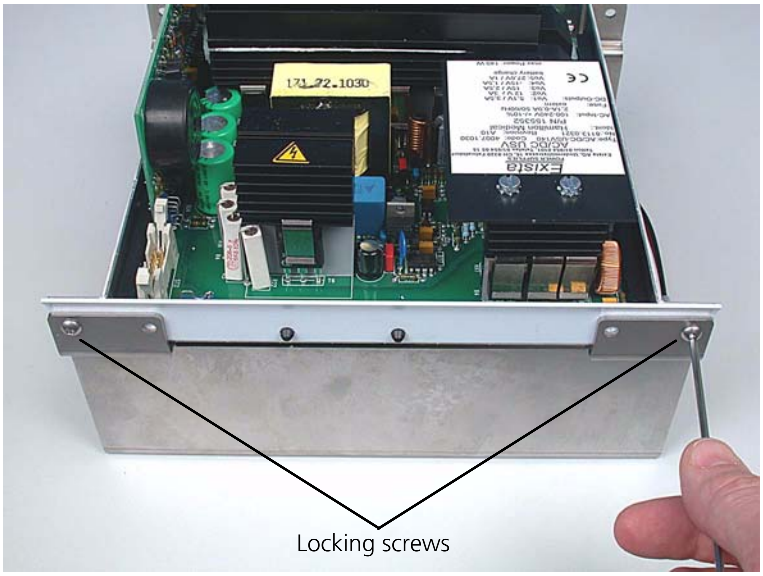


Figure 11-19. Removing the screws securing the locking bar

7. Raise the board, and remove the bar. (Figure 11-20.)

Figure 11-20. Removing the locking bar

8. Turn the power supply around, and slide the power supply board from its housing.

Note
The grip shown in the photograph is important, as the fitting is sometimes tight. (Figure 11-21.)

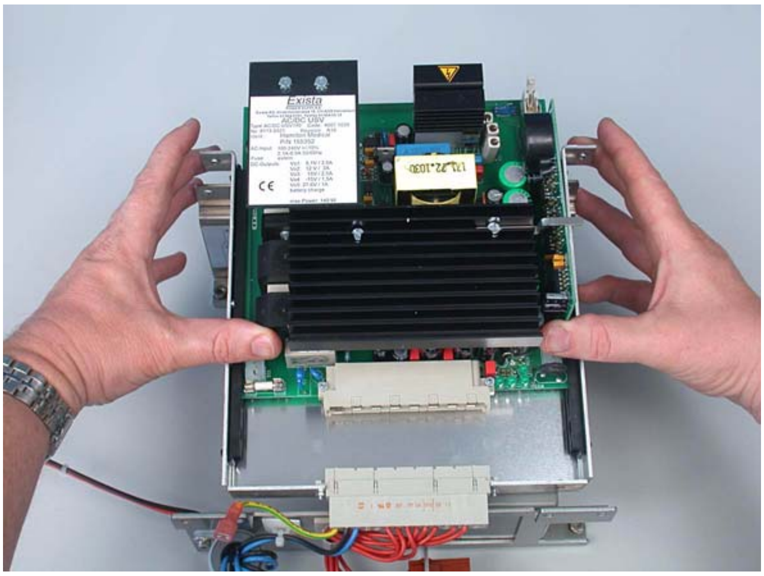


Figure 11-21. Sliding the power supply board from its housing

9. Swing the power supply board mounting plate aside. (Figure 11-22.)

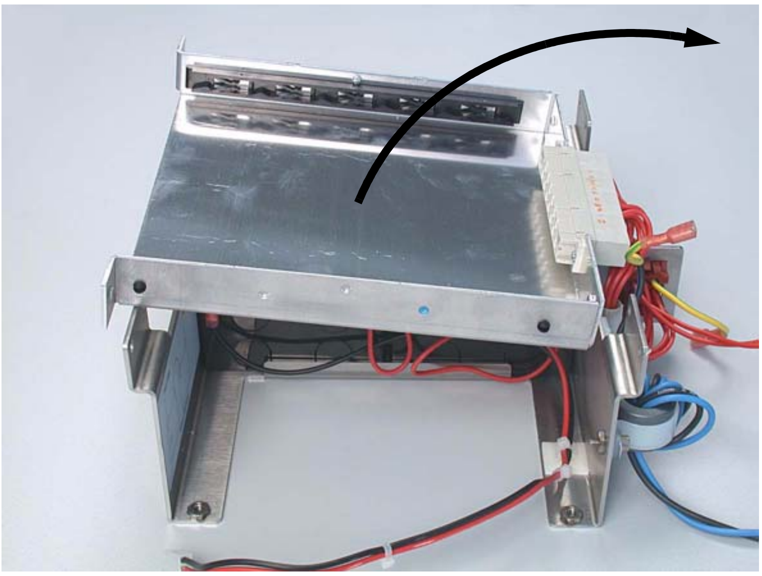


Figure 11-22. The mounting plate

10. The backup batteries are now revealed. (Figure 11-23.)

Figure 11-23. The backup batteries in the chassis

11. You can now test or replace the backup batteries as required.

11.7 Ambient valve and patient overpressure valve

CAUTION

Do not attempt to repair the ambient valve or patient overpressure valve. HAMILTON MEDICAL AG does not permit anyone to make any repairs in the field at a level lower than the smallest parts provided in Appendix H, *Spare parts*.

11.7.1 References

- Position in gas flow:
  - Section 2.2, *Components managing the principle gas flow*, on page 2-2
  - Section 2.4, *Components managing the patient and tank overpressure-relief gas-flows*, on page 2-12
  - Section 2.5, *Components managing the ambient state gas flow*, on page 2-14
- Testing:
  - Test 12.5, *Performing the patient overpressure-valve check*, on page 9-59
  - Test 13, *Ambient Valve*, on page 9-61

  Or:
  - Unit 12.5, *Performing the patient overpressure-valve check*, on page 10-72
  - *13: Ambient valve check*, on page 10-73
- Part number (of safety valve block including the patient and overpressure valves): PN 155338, shown in Appendix H.10, *Valves and assembly groups*, on page H-9.

11.7.2 Placement

Both the ambient valve and the patient overpressure valve are integrated into the *safety valve block*. The safety valve block is screwed to the base of the chassis, as shown in Figure 11-24 below and Figure 2-1, *Components managing the principle gas flow*, on page 2-2.

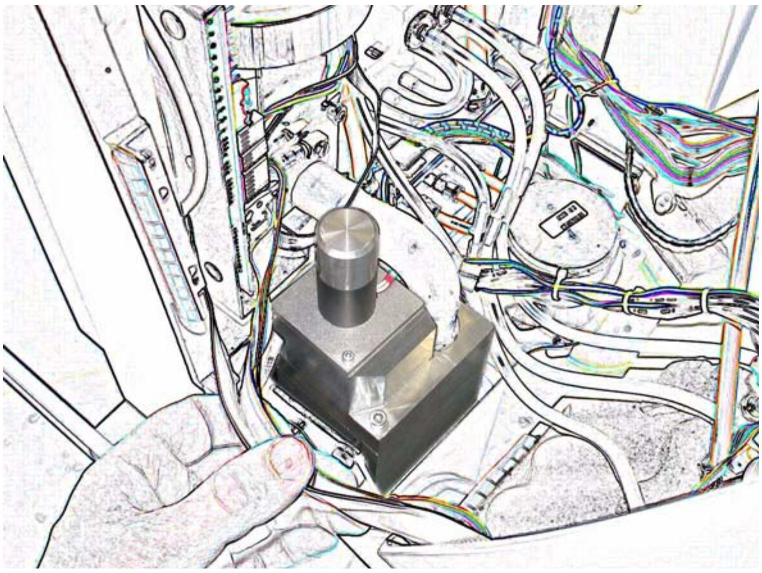


Figure 11-24. **Position of the safety valve block inside the rear enclosure**

11.7.3 Purpose

Ambient valve

The purpose of the *ambient valve* is to enable a patient to inhale ambient air — if he is able to do so — in the event of a complete failure of GALILEO. The ambient valve opens when unpowered, thereby opening the patient circuit to the surrounding room air.

Note

- The ambient valve makes inhalation possible for a patient who is able to breathe for himself. It does not actively aid the patient to breathe in any way.
- Complete ventilator failure causes GALILEO to go into the *ambient state*. In this state, the *inspiratory (servo) valve* closes, the *expiratory valve* valve opens, and the *mixer valves* shut off the air and oxygen supply to the tank.

For information about gas flow through the ambient valve in the context of the complete pneumatic system, see Section 2.5, *Components managing the ambient state gas flow*, on page 2-14.

Patient overpressure valve

The purpose of the *patient overpressure valve* is to prevent the patient breathing circuit from being able to reach very high pressures in the case of GALILEO malfunctioning. The valve opens at approximately 110 mbar.

This valve functions as an additional backup to the pressure limit set by the user for the patient circuit.

11.7.4 Description and function

During normal ventilation, gas from the tank passes through the safety valve block as shown on the left side of Figure 11-25.

In event of overpressure in the patient circuit, the overpressure valve opens as shown on the right side of Figure 11-25. This is a simple, non-electronic valve, which is held closed with a spring during normal ventilation.

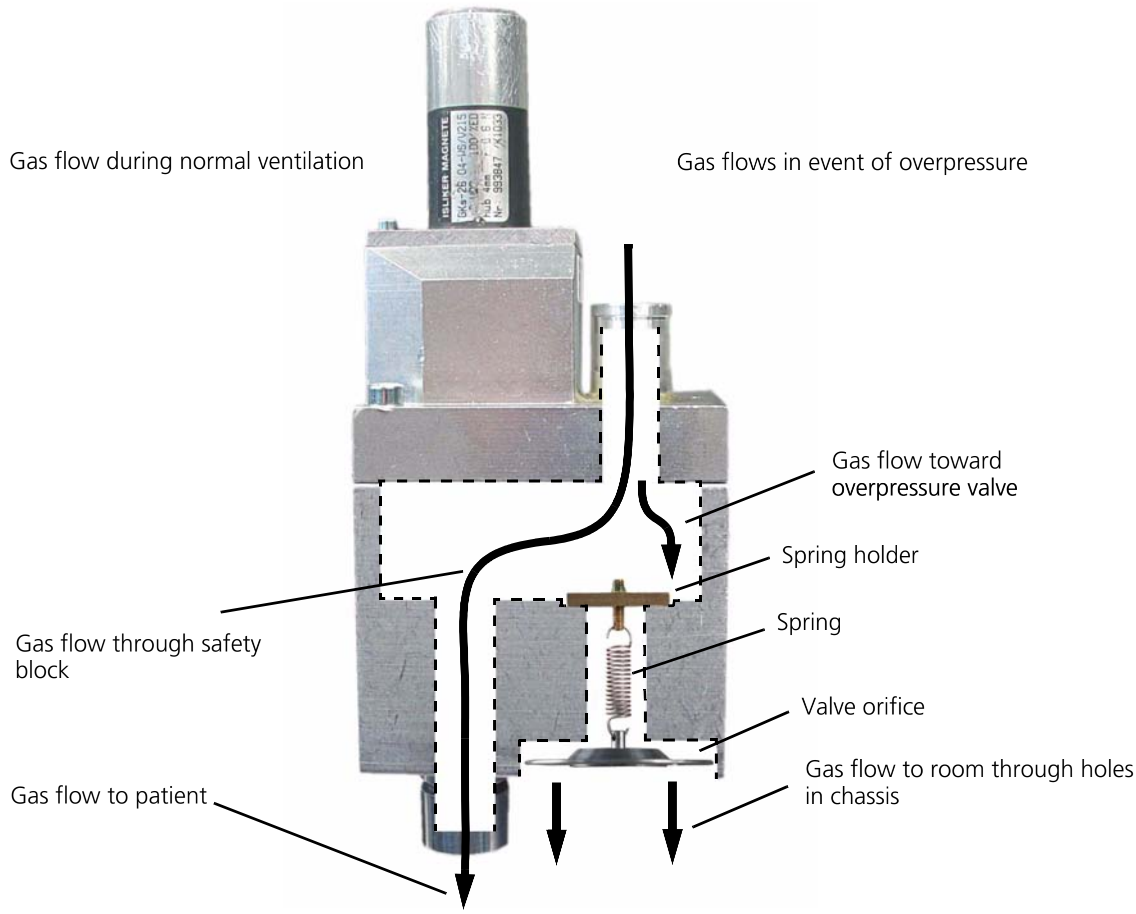


Figure 11-25. Front view of safety valve block, showing normal and overpressure gas flows

In event of a complete system failure, the solenoid controlling the ambient valve is deactivated. In this state, the ambient valve can open if the patient is able to actively draw breath. This is shown in Figure 11-26.

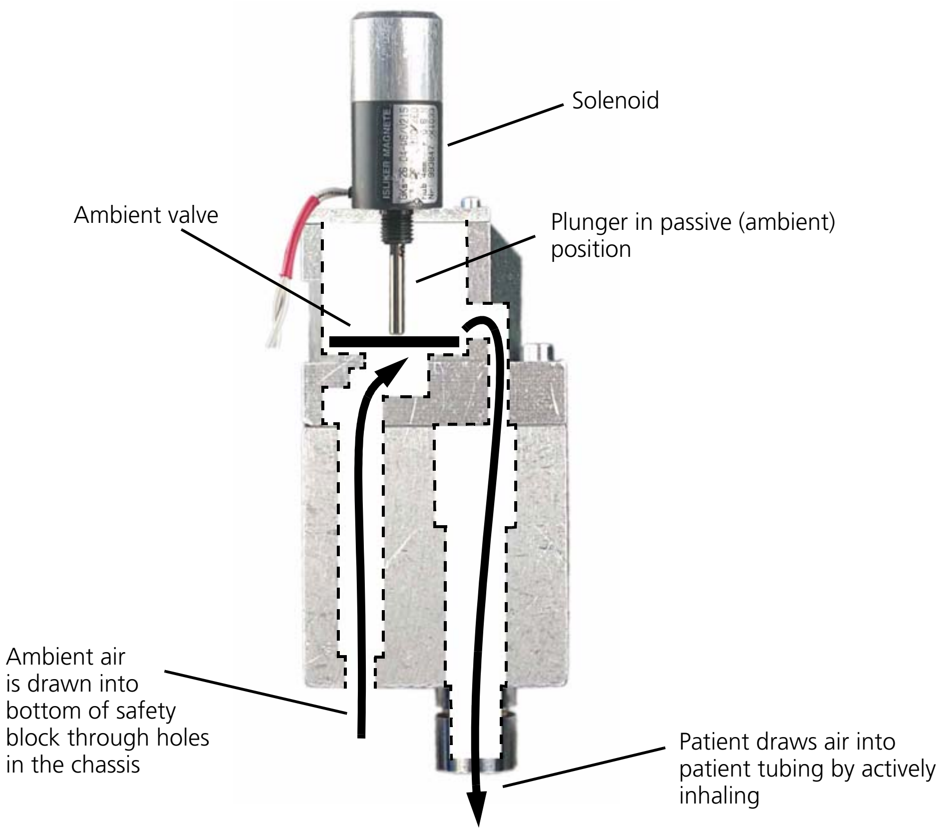


Figure 11-26. Side view of safety valve block, showing action of ambient valve

11.7.5 Maintaining and replacing the ambient and patient overpressure valves

Two procedures are explained in this section:

- Section 11.7.5.1, *Replacing the ambient valve solenoid coil*
- Section 11.7.5.2, *Replacing the safety valve block*

Note
With the exception of changing the ambient valve solenoid coil, you cannot make adjustments or repairs to the safety valve block.

11.7.5.1 Replacing the ambient valve solenoid coil

Removing the coil

1. Open GALILEO's main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
2. Locate the safety valve block, into which the solenoid is screwed. (See Section 11.7.2, *Placement*.)

3. Remove the cable connector belonging to the ambient valve solenoid from the *connector board*. (Figure 11-27.)

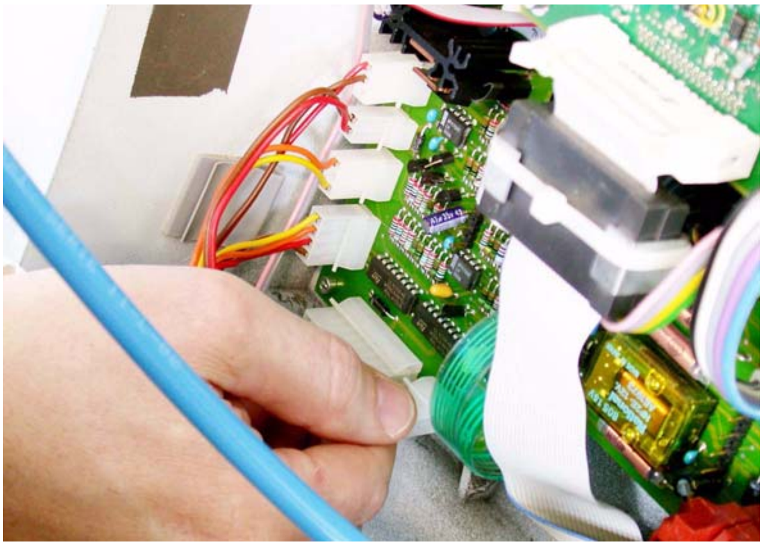


Figure 11-27. Removing the cable connector belonging to the ambient valve

4. Remove the solenoid cable from the cable grip. The grip comprises two parts, as shown in Figure 11-28. You open the grip by “unbending” the two plastic wings as indicated by the arrow.

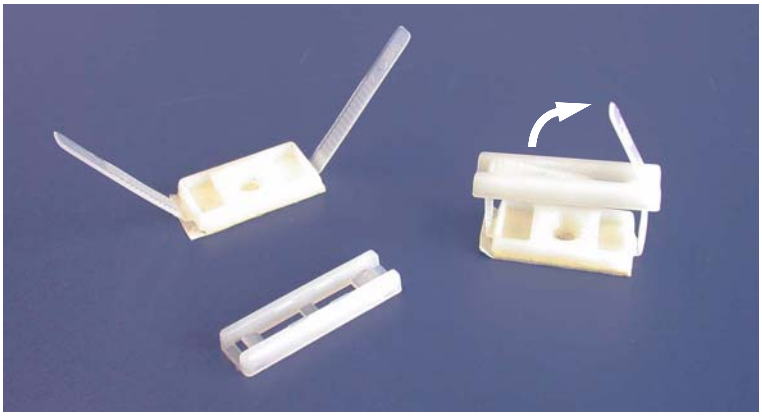


Figure 11-28. Cable grip PN 361007

5. Holding the cable above the solenoid, unscrew the solenoid from the safety valve block. (Figure 11-29.)

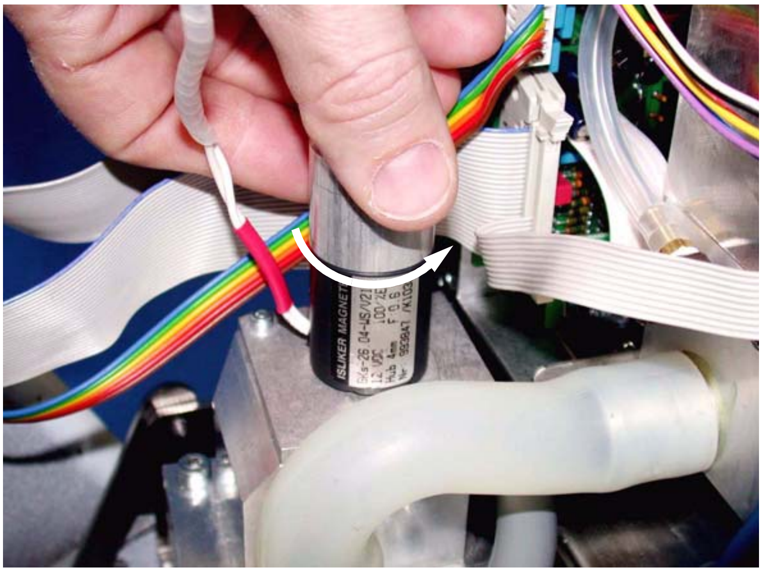


Figure 11-29. Unscrewing the ambient valve solenoid

Fitting the new ambient valve solenoid

To fit the new solenoid, reverse the removal procedure.

Testing

WARNING

You must perform all the following tests.

After fitting a new ambient valve solenoid, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
  - Section 9, *Running Original or Upgrade 1 test software*
  - Section 10, *Running Upgrade 2 test software*

11.7.5.2 Replacing the safety valve block

Note

You cannot repair either the ambient valve or the patient overpressure valve. Furthermore, you cannot replace the ambient valve or the patient overpressure valve separately—you must replace the complete safety valve block.

Removing the safety valve block

1. Perform step 1 to step 4 in Section 11.7.5.1, *Replacing the ambient valve solenoid coil*.

2. Remove the hexagonal-drive (Allen) screw holding the cable grip in place on top of the safety valve block. (Figure 11-30.)

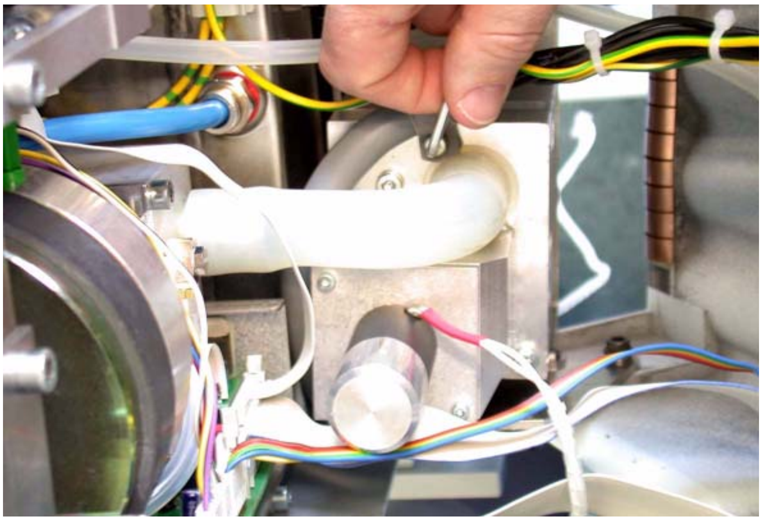


Figure 11-30. Removing the cable grip

3. Remove the white tube connected to the *inspiratory (servo) valve*. (Figure 11-31.)

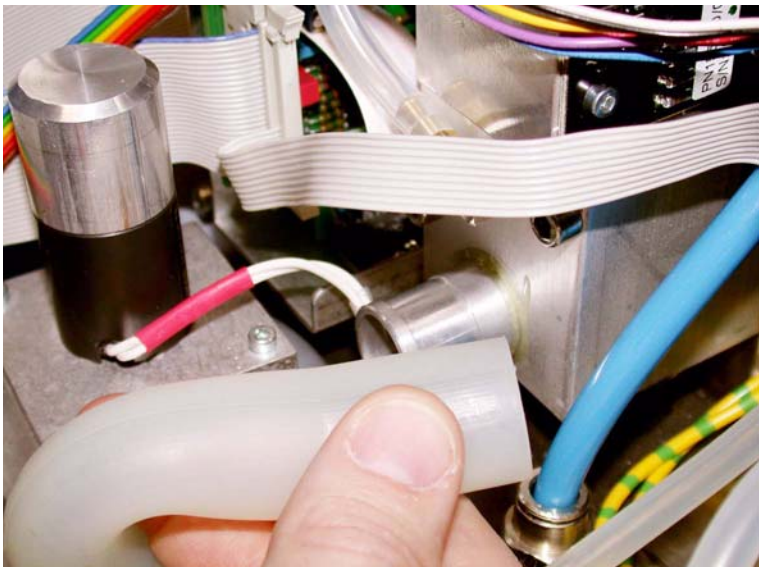


Figure 11-31. Removing the tube from the expiratory valve

4. Remove the two hexagonal-drive (Allen) screws holding the safety valve block in place. These are positioned near the to-patient port. (Figure 11-32.)

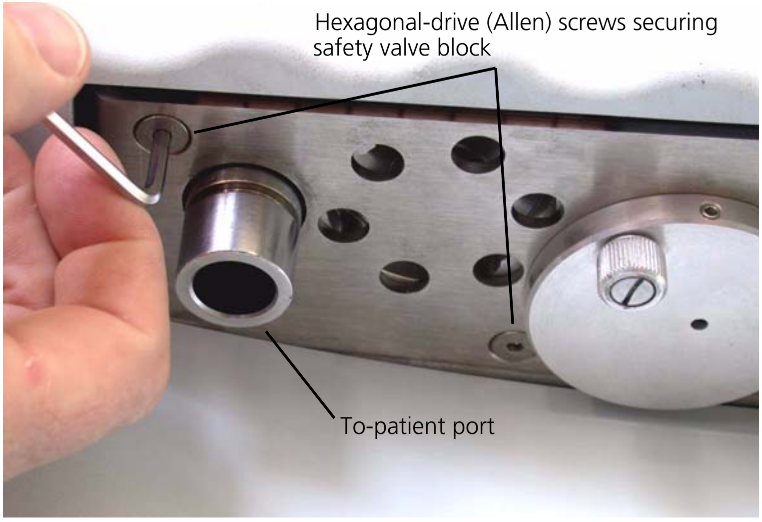


Figure 11-32. Position of the screws securing the safety valve block

5. Lift out the safety valve block.

Fitting the new ambient valve and patient overpressure valve

To fit the new ambient and patient overpressure valves, reverse the removal procedure.

Testing

WARNING

You must perform all the following tests.

After fitting a new safety valve block, perform all the tests in:

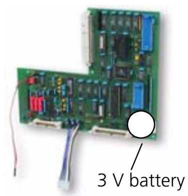
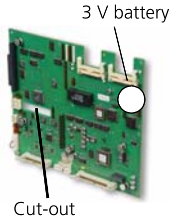
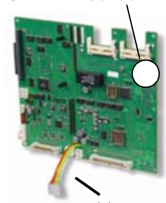
- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
  - Section 9, *Running Original or Upgrade 1 test software*
  - Section 10, *Running Upgrade 2 test software*

11.8 Battery, 3 V

11.8.1 References

- Position in enclosure: Figure 3-1, *Components in the front enclosure*, on page 3-2.
- Testing: Section 7.3, *Checking voltages*, on page 7-3.
- Part number: PN 369069, shown in Appendix H.19, *Miscellaneous*, on page H-25.

11.8.2 Placement

<table>
<tr><th rowspan="2"></th><th colspan="2">PN 155154</th><th colspan="2">PN 155461</th></tr>
<tr><th>Original GALILEO</th><th>Upgrade 1 GALILEO</th><th colspan="2">Upgrade 2 GALILEO</th></tr>
<tr><th>Control board</th>
<td>PN 155154
</td>
<td>PN 155154
</td>
<td>PN 155461
Rev 00 to 03
</td>
<td colspan="2">PN 155461
Rev 04 and later
</td></tr>
<tr><th>GMP hardware</th>
<td>PN 396138
</td>
<td>PN 155460
</td>
<td>PN 155499
</td>
<td>Early versions of PN 155461 Rev 04.
PN 155499
</td>
<td>Later versions of PN 155461 Rev 04, Rev 05, and later.
Note
No 3 V battery present.
CPU module
PN 396170

LCD adaptor
PN 155563
</td></tr>
</table>

Table 11-1. 3 V battery positions

The 3 V battery can be mounted in one of three places:

- On *control board* PN 155154, when used with GMP assembly PN 396138, the 3 V battery is mounted on the bottom right of the control board. (Figure 11-33.)
- On control board PN 155154, when used with GMP assembly PN 155460, the 3 V battery is mounted on the GMP assembly.
- On control board PN 155461 Rev 00 to 03, when used with GMP assembly PN 155499, the 3 V battery is on the top right of the board. (Figure 11-34.)
- On control board PN 155461 Rev 04, when used with GMP assembly PN 155499, the 3 V battery is on the top right of the board. (Figure 11-34.)

On control board PN 155461 Rev 04 and later, when used with GMP assembly PN 396170, ***there is no 3 V battery***. Instead, a long-life battery is permanently mounted on the GMP assembly.

Note

When using GMP assembly PN 396170, you must make sure the micro-switches on control board PN 155461 are correctly set. For more information, see *Microswitch settings for GMP assemblies* on page 11-51.

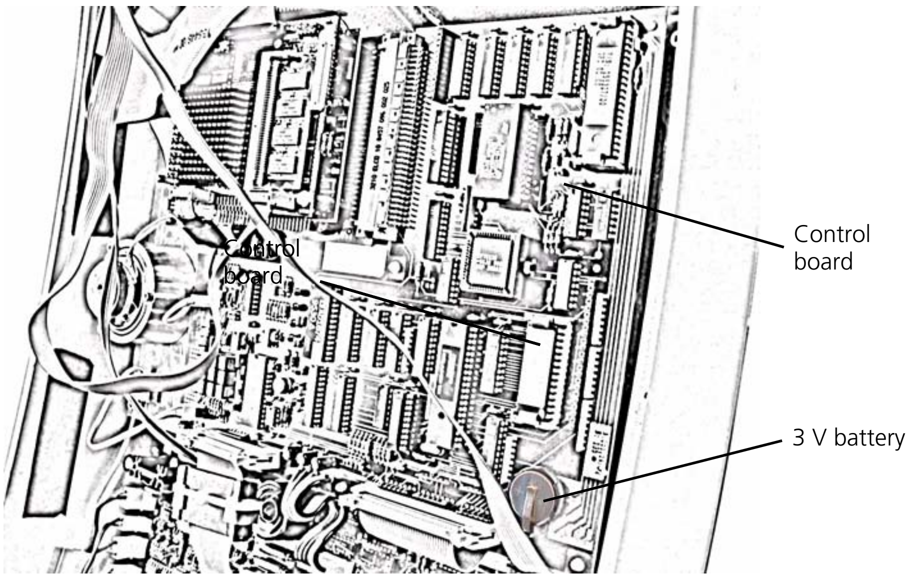


Figure 11-33. Position of the 3 V clock battery on control board PN 155154

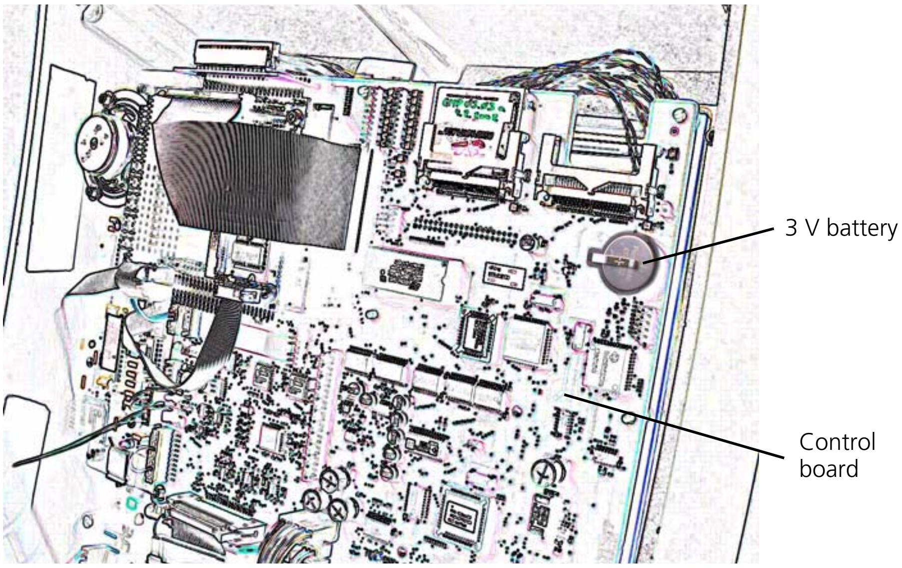


Figure 11-34. Position of the 3 V clock battery on control board PN 155461

11.8.3 Purpose

The purpose of the 3 V battery is to provide power for the internal clock.

However, in GALILEOs with control board PN 155461 Rev 04 (and later) combined with GMP CPU module PN 396170 and GMP LCD adapter PN 155563, the power for the internal clock comes from the long-life battery mounted on the GMP CPU module. In this case, the 3 V "button" battery serves no purpose, and must not be mounted on the control board.

11.8.4 Description and function

The replaceable version of the battery is a normal 3 V "button" battery. The long-life battery mounted on the GMP CPU module PN 396170 is not replaceable.

CAUTION

To be sure that you obtain the correct "button" battery, always order this item from HAMILTON MEDICAL AG, using the part number shown in Appendix H, *Spare parts*.

11.8.5 Further information

CAUTION

If a 3 V “button” battery is not mounted on the control board (in other words, when GMP PN 155460 or PN 396170 are fitted) it is important that the empty battery holder on the control board does not create a short circuit. If necessary, bend the securing grip upwards, so that no short circuit can occur. (Figure 11-35.)

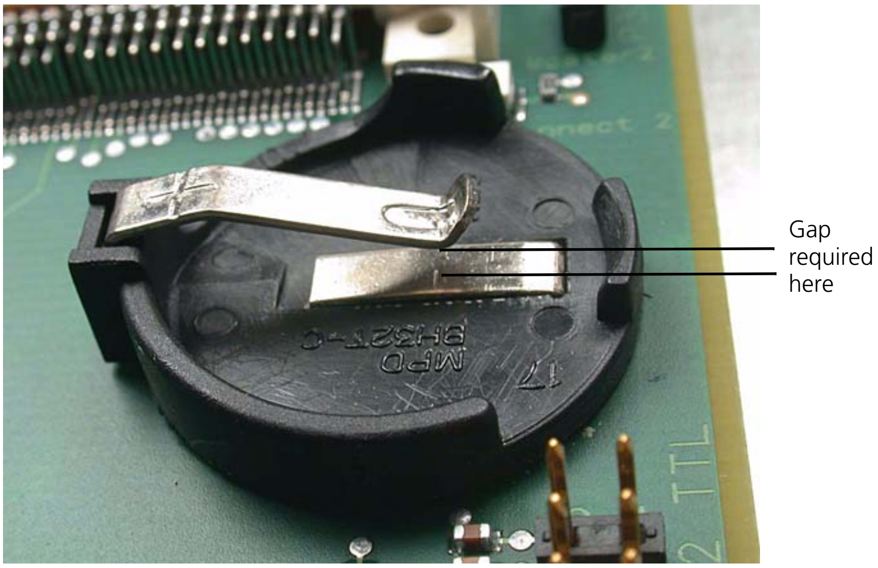


Figure 11-35. Detail of 3 V battery holder

11.8.6 Replacing the 3 V “button” battery

Replace the 3 V “button” battery when required by Section 6.1, *Engineer preventive maintenance*, on page 6-1, or if the date and time setting becomes unreliable.

Note
You cannot replace the long-life battery on GMP CPU module PN 396170.

When you replace the 3 V battery, make a note in the GALILEO test report. You can photocopy one of the following reports from the back of this manual:

- *GALILEO Original and Upgrade 1 Test Report*
- *GALILEO Upgrade 2 Test Report*

Removing the 3 V “button” battery

1. Open GALILEO’s main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
2. Locate the 3 V “button” battery, as shown in Section 11.8.2, on page 11-27.
3. Remove the battery from its holder. With some types of control board, you can push the battery out of its holder with a thumb. (The battery holder is marked **Push**.)

However, with other types, you must ease the battery out by first lifting it, and then pushing it out with a suitable non-metallic tool, such as a plastic potentiometer trimmer. (Figure 11-36.)

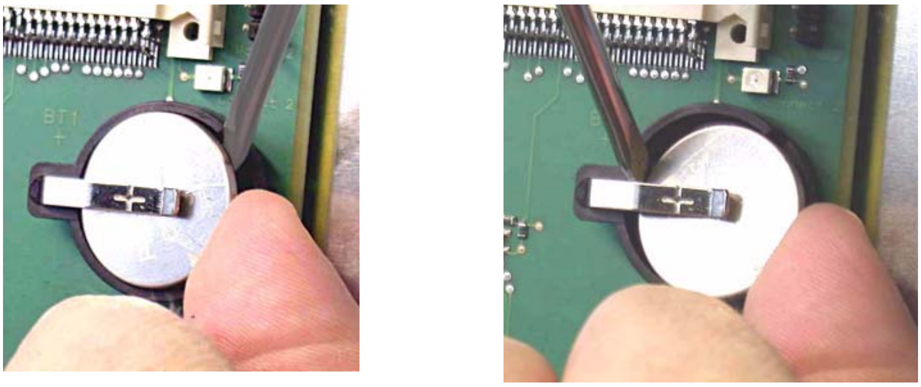


Figure 11-36. **Lifting and then pushing out the 3 V battery with a plastic trimmer**

Replacing the 3 V "button" battery

1. Push the replacement battery into the holder.
2. Close GALILEO's main enclosure using the four hexagonal-drive (Allen) screws.
3. Check that the date and time are correct. (If the battery replacement took only a few minutes, it is unlikely that the date and time have changed.)
   To do this, first access the **`Configuration`** menu, and then the **`Clock`** menu. Full details are given in the GALILEO operators' manuals.
4. Recycle the old battery, or return it to HAMILTON MEDICAL.

Testing

WARNING

You must perform all the following tests.

After fitting a new 3 V battery, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
  - Section 9, *Running Original or Upgrade 1 test software*
  - Section 10, *Running Upgrade 2 test software*

11.9 Batteries, 12 V

11.9.1 References

- Position in enclosure: Section 3.4, *Components in the column*, on page 3-12.
- Testing: See the appropriate GALILEO operators' manual.
- Part number: PN 369089, shown in Appendix H.19, *Miscellaneous*, on page H-25.

11.9.2 Placement

The batteries are mounted in the column, as shown in Figure 11-37 below, and on Figure 3-3 on page 3-12.

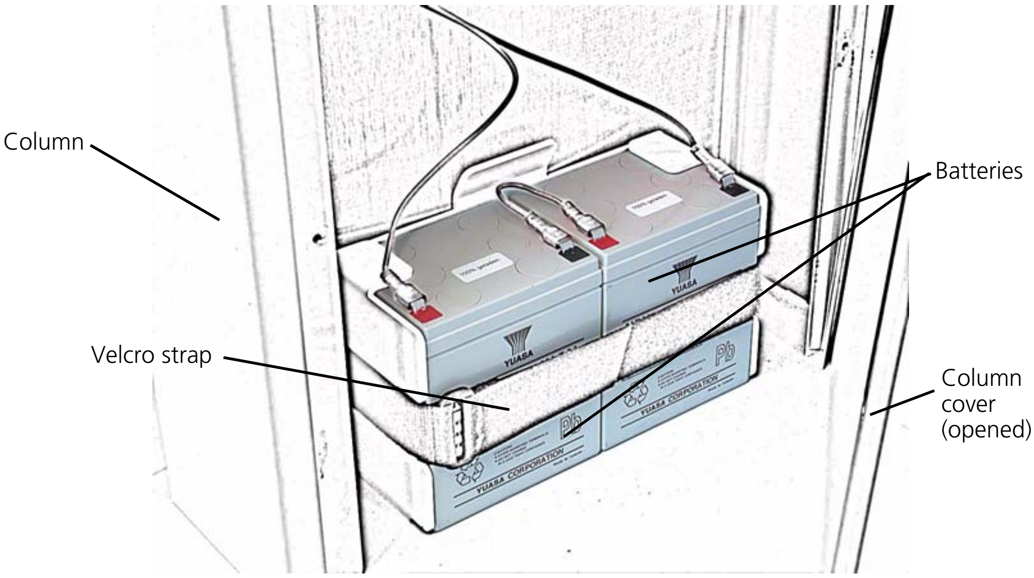


Figure 11-37. Position of the 12 V batteries in the opened column

11.9.3 Purpose

The purpose of the 12 V backup batteries is to provide a source of temporary power for GALILEO in the event that mains power is lost or is unstable. The batteries are not intended as a primary alternative power source.

11.9.4 Description and function

The batteries comprise two sealed lead/acid units that enable GALILEO to function without mains power for at least 20 minutes (when new and fully charged). The switchover from ac to battery power is automatic and immediate, causing no interruption in ventilation. The switchover generates

an automatic alarm that the user can silence by pressing the alarm silence key on the battery panel, on the front of the column. (Figure 11-38.)

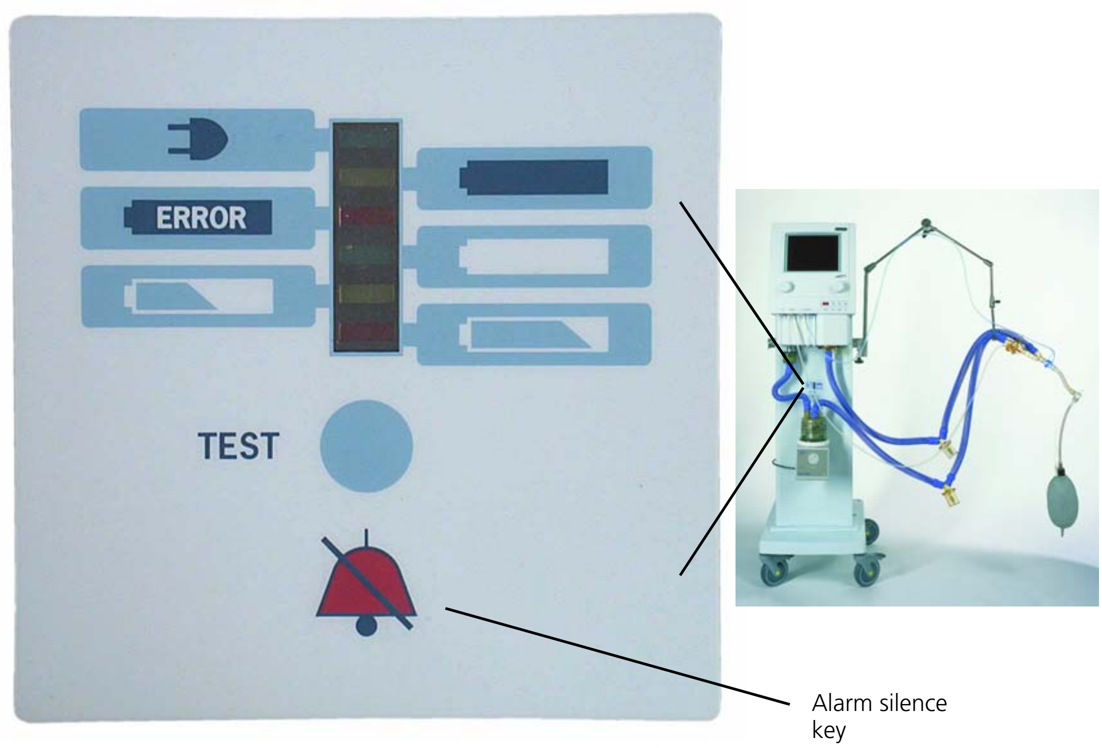


Figure 11-38. The alarm silence key on the battery panel

GALILEO recharges the batteries whenever it is connected to ac mains power, independently of whether the on/off switch at the rear of the column is switched on.

Note
For more information about the battery panel, see the appropriate GALILEO operators' guide.

11.9.4.1 Replacement frequency

The 12 V backup batteries require no maintenance, but should be replaced every two years, according to the schedule in Section 6.1, *Engineer preventive maintenance*, on page 6-1. If you are not sure of the age of your batteries, see Section 11.9.4.5, *Determining the age of your batteries*, on page 11-34.

WARNING
Do not cause a short circuit accross the backup batteries. Because GALILEO can run on battery power when mains power is disconnected, it is possible to cause a short circuit at a point distant from the batteries when GALILEO is switched on.

11.9.4.2 GALILEOs on which battery backup is fitted

On earlier GALILEOs, the battery-backup was a factory- or field-fitted option, and was not available for short-column or shelf-mount models. However, the battery backup is now fitted to all GALILEOS.

11.9.4.3 Running and charging times

As stated above, the time that GALILEO can function on battery power is specified as a minimum of 20 minutes with new, fully charged batteries. However, the actual operating time depends on the ventilator settings and battery age, and can be longer than 20 minutes.

The recharge time for the batteries is 8 hours minimum (the batteries recharge whenever GALILEO is connected to ac mains.)

11.9.4.4 Storage

Batteries can be stored in or out of GALILEO. In either case, the following guidelines must be obeyed:

Temperature	-20 to 40 °C (-4 to 104 °F), preferably below 30 °C
Relative humidity	25 to 85%
General	The storage place must be free from vibration, dust, direct sunlight, and moisture.

Table 11-2. 12 V battery storage guidelines

Independently of the manner in which batteries are stored, they must be recharged regularly. The following table gives guidelines for routine recharging:

Storage temperature	Recharge interval	Recharge time
Below 20 °C (68 °F)	Every 6 months	8 hours
20 °C to 30 °C (68 °F to 86 °F)	Every 3 months	8 hours
Over 30 °C (86 °F)	Every month	8 hours

Table 11-3. 12 V battery routine recharging guidelines

Note
If batteries are stored in GALILEO they can be recharged simply by connecting GALILEO to mains power.

11.9.4.5 Determining the age of your batteries

Every battery carries a date code indicating its year of manufacture. There are two battery types (old and new), that together use a total of four code systems.

Old, black batteries

The old type of battery is black, and is shown in Figure 11-39.

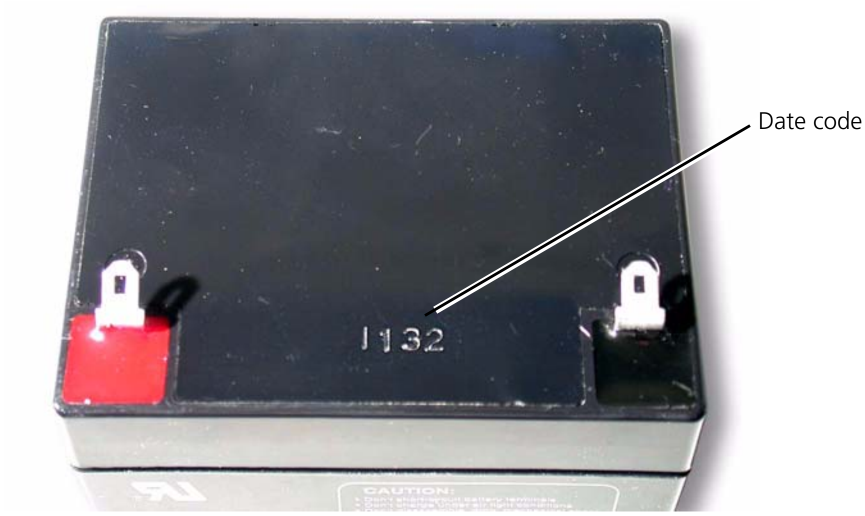


Figure 11-39. The old 12 V battery type

There is only one date code system for this battery type. It has the following structure:

Code key	Explanation	Example for code I132
y w w d	• *y* is one of the following upper case alphabetic characters, and indicates the ***year*** of manufacture: • H (1998) • I (1999) • J (2000) • K (2001) • L (2002) • M (2003)	• I The year 1999.
	• *w w* is a pair of numerals, and indicates the ***week*** of manufacture.	• 13 The thirteenth week of the year.
	• *d* is a numeral, and indicates the ***day*** of manufacture.	• 2 The second day of the week: tuesday.

Table 11-4. Old black battery code

New, grey batteries

The new type of battery is grey, and is shown in Figure 11-40.

Figure 11-40. The new 12 V battery type (made in Taiwan)

There are ***three*** date code systems for this battery type, depending on where the batteries are manufactured, Taiwan, Japan, or United Kingdom and United States. (All batteries are clearly marked with the place of manufacture.)

New batteries made in Taiwan use the following code:

Code key	Explanation	Example for code 0206133Q
y y m m d d f c	• *y y* is a pair of numerals, and indicates the ***year*** of manufacture.	• 02 The year 2002.
	• *m m* is a pair of numerals, and indicates the ***month*** of manufacture.	• 06 The sixth month of year: June.
	• *d d* is a pair of numerals, and indicates the ***day*** of the month of manufacture.	• 13 The thirteenth day of the month.
	• *f* is a numeral, and indicates a ***factory*** (unimportant for HAMILTON MEDICAL AG).	• 3 The factory code 3 (unimportant).
	• *c* is an upper case alphabetic character, and indicates a ***code*** associated with manufacture (unimportant for HAMILTON MEDICAL AG).	• Q The code 3 (unimportant).

Table 11-5. Taiwan battery code

New batteries made in Japan use the following code:

Code key	Explanation	Example for code 9703211
y y m m d d c	• *y y* is a pair of numerals, and indicates the ***year*** of manufacture.	• 97 The year 1997.
	• *m m* is a pair of numerals, and indicates the ***month*** of manufacture.	• 03 The third month of year: March.
	• *d d* is a pair of numerals, and indicates the ***day*** of the month of manufacture.	• 21 The twenty-first day of the month.
	• *c* is a numeral, and indicates a ***code*** associated with manufacture (unimportant for HAMILTON MEDICAL AG).	• 1 The code 1 (unimportant).

Table 11-6. Japan battery code

New batteries made in the United Kingdom and United States of America use the following code:

Code key	Explanation	Example for code 7032152
y m m d d c c	• *y* is a numeral, and indicates the ***year*** of manufacture.	• 7 The year 1997.
	• *m m* is a pair of numerals, and indicates the ***month*** of manufacture.	• 03 The third month of year: March.
	• *d d* is a pair of numerals, and indicates the ***day*** of manufacture.	• 21 The twenty-first day of the month.
	• *c c* is a pair of numerals, and indicates a manufacturing ***code*** (unimportant for HAMILTON MEDICAL AG).	• 52 The manufacturing code 52 (unimportant).

Table 11-7. UK and USA battery code

11.9.5 Replacing the 12 V backup batteries

The 12 V backup batteries require no maintenance, but should be replaced every two years, according to the schedule in Section 6.1, *Engineer preventive maintenance*, on page 6-1.

When you replace the backup batteries, make a note in the GALILEO test report. You can photocopy one of the following reports from the back of this manual:

- *GALILEO Original and Upgrade 1 Test Report*
- *GALILEO Upgrade 2 Test Report*

If you are not sure of the age of your batteries, see *Determining the age of your batteries* on page 11-34.

To replace the batteries:

1. Open the column, as described in Section 11.5, *Opening the column*, on page 11-6.

Note
It is not necessary to disconnect any electrical connections.

2. Make a note of the wiring on the batteries. (Figure 11-41.)

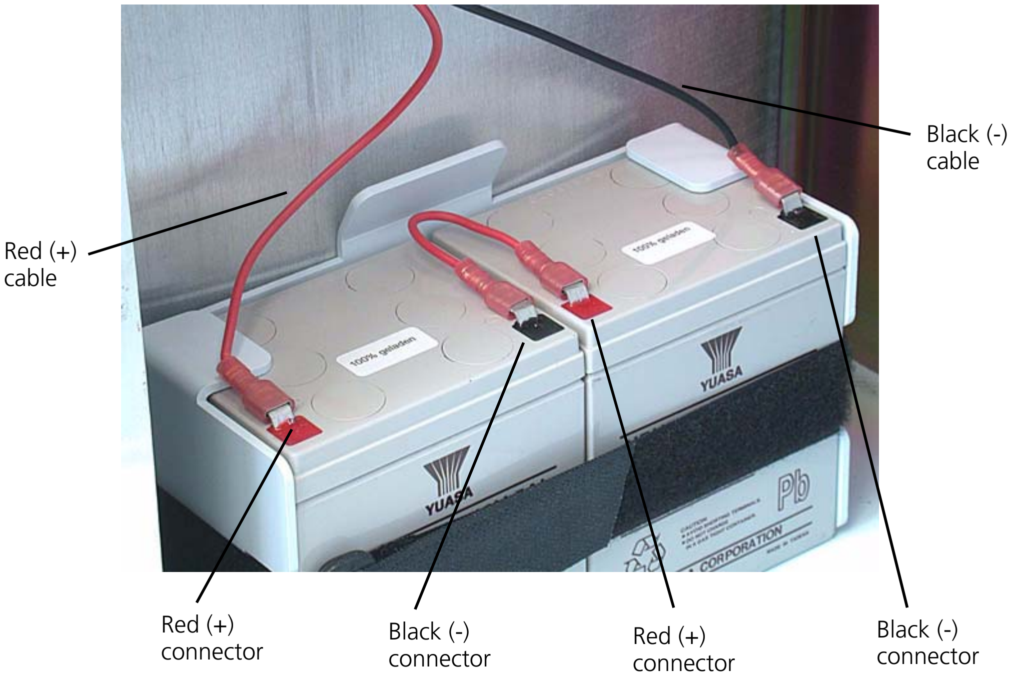


Figure 11-41. Placement of wires on the backup batteries

3. Remove the Velcro strap and wires, and replace the batteries.
4. Screw the cover back onto the column.
5. Recycle the batteries, or return them to HAMILTON MEDICAL AG for disposal.

Testing

WARNING

You must perform all the following tests.

Perform the 12 V battery test described in Section 3, *Tests and calibrations*, in the appropriate GALILEO operators' manual. After GALILEO passes this test, perform all the tests in the following sections of this manual:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
  - Section 9, *Running Original or Upgrade 1 test software*
  - Section 10, *Running Upgrade 2 test software*

11.10 Connector board

WARNING

- **If any GALILEO for which you are responsible does not have battery backup, make sure that the connector board in that GALILEO is PN 155256 Rev 05 or higher. Connector boards of earlier revisions can be associated with unreliable emergency alarm performance if mains power is switched off.**
- **If necessary, fit a new board now, as described in Section 11.10.6, *Replacing the connector board*, on page 11-40.**

CAUTION

Do not attempt to repair the connector board. HAMILTON MEDICAL AG does not permit anyone to make board-level repairs to GALILEO in the field. If a board is faulty, you must replace it with a new one.

11.10.1 References

- Position in enclosure: Section 3.2, *Components in the front enclosure*, on page 3-2.
- Testing: There is no specific test for the connector board.
- Part number: PN 155256, shown in Appendix H.7, *Boards*, on page H-5.

11.10.2 Placement

The connector board is located in the front enclosure, below the large control board, as shown in Figure 11-42 below, and Figure 3-1, *Components in the front enclosure*, on page 3-2.

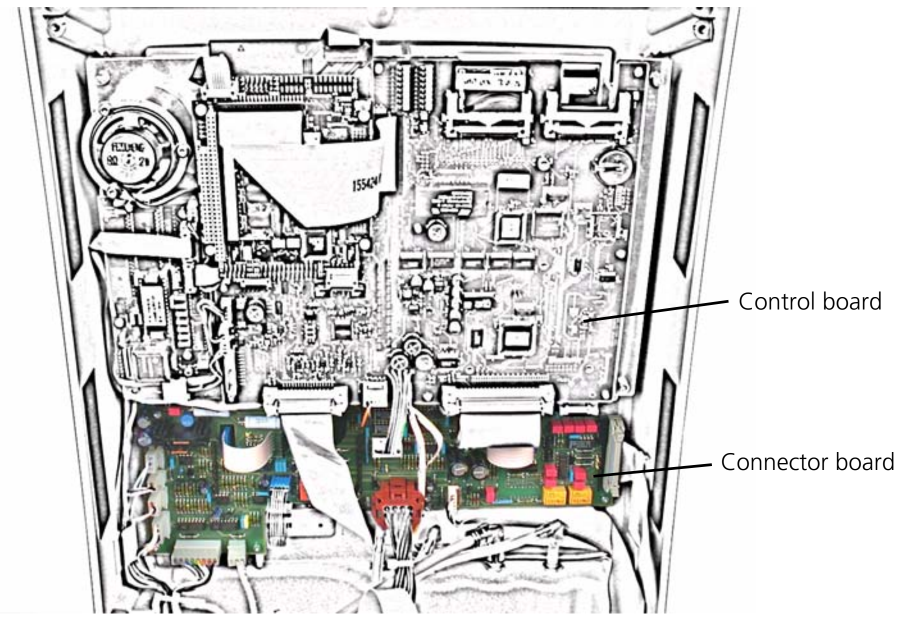


Figure 11-42. **Position of the connector board inside the front enclosure**

11.10.3 Purpose

The purpose of the connector board is to manage:

- Other circuit boards
- Valves
- Keys on the front of the GALILEO
- P&T-knobs

It is also the board on which the *buzzer* is mounted.

11.10.4 Description and function

The connector board is the printed circuit board with the most connections to valves. It has a direct connection to the power supply in the column, and houses the power amplifiers and switches for control of most valves.

In addition, it houses the interface for the P&T knobs and encoders shown in Figure 3-1, *Components in the front enclosure*, on page 3-2, and provides galvanic separation for the optional communication interface documented in Appendix B, *Communication interface specifications*.

11.10.5 Further information

11.10.6 Replacing the connector board

Note
If you replace a connector board

Removing the connector board

1. Open GALILEO's main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
2. Locate the connector board. (Figure 11-42 on page 11-39.)
3. Unplug from the connector board all cables joining the board to other parts of the GALILEO.

Make sure to unplug the two ribbon cables that connect through the board to the P&T-knob encoders. (Figure 11-43.)

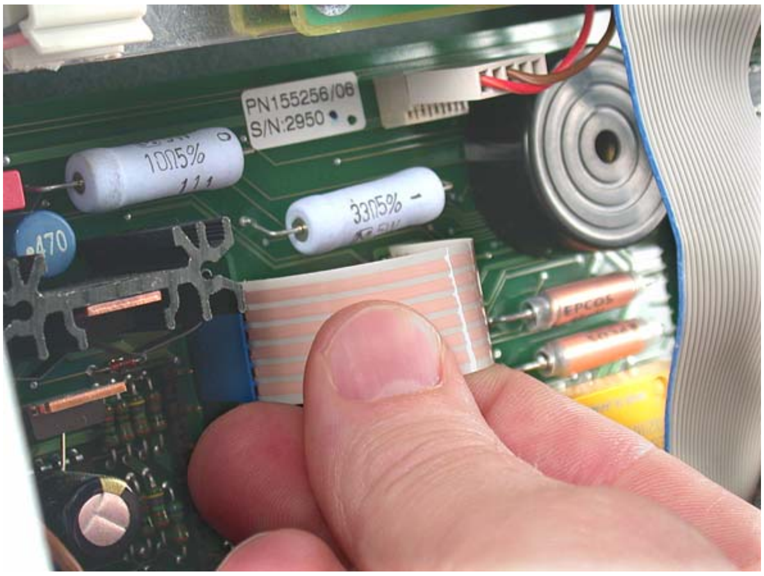


Figure 11-43. Removing a ribbon cable to a P&T-knob encoder

4. Remove the seven hexagonal-drive (Allen) screws that secure the board to the front enclosure, and remove the board.

Fitting the new connector board

To fit the new board, simply reverse the removal procedure. Make sure that you correctly place all the cables.

- Figure 11-44 on page 11-42 shows connections for connector boards revisions 00 to 08.
- Figure 11-45 on page 11-43 shows connections for the slightly different revision 09 and later boards. These are supplied complete with cables PN 155548 and PN 155569.

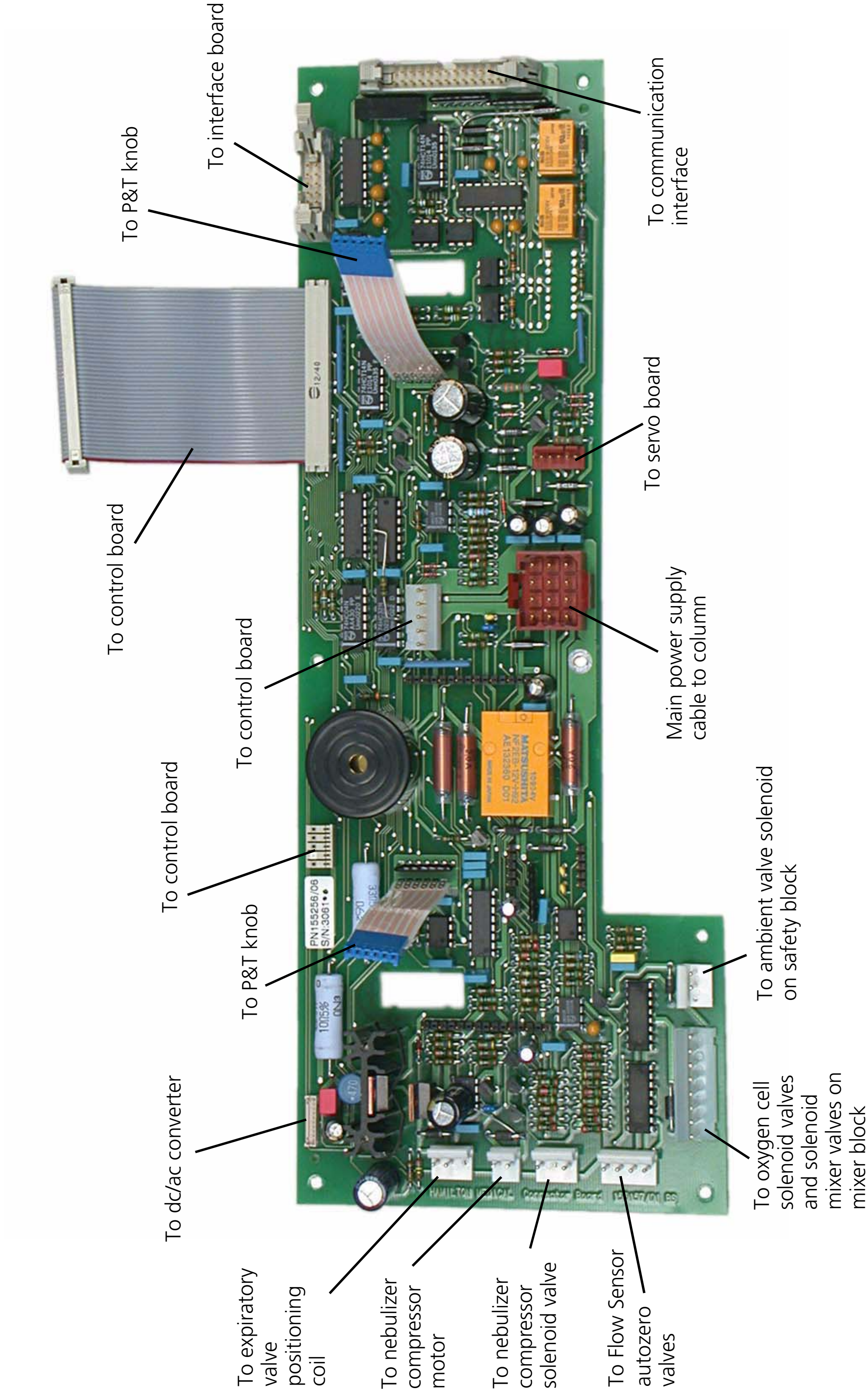


Figure 11-44. Cable connections to connector board PN 155256 Revs 0 to 8

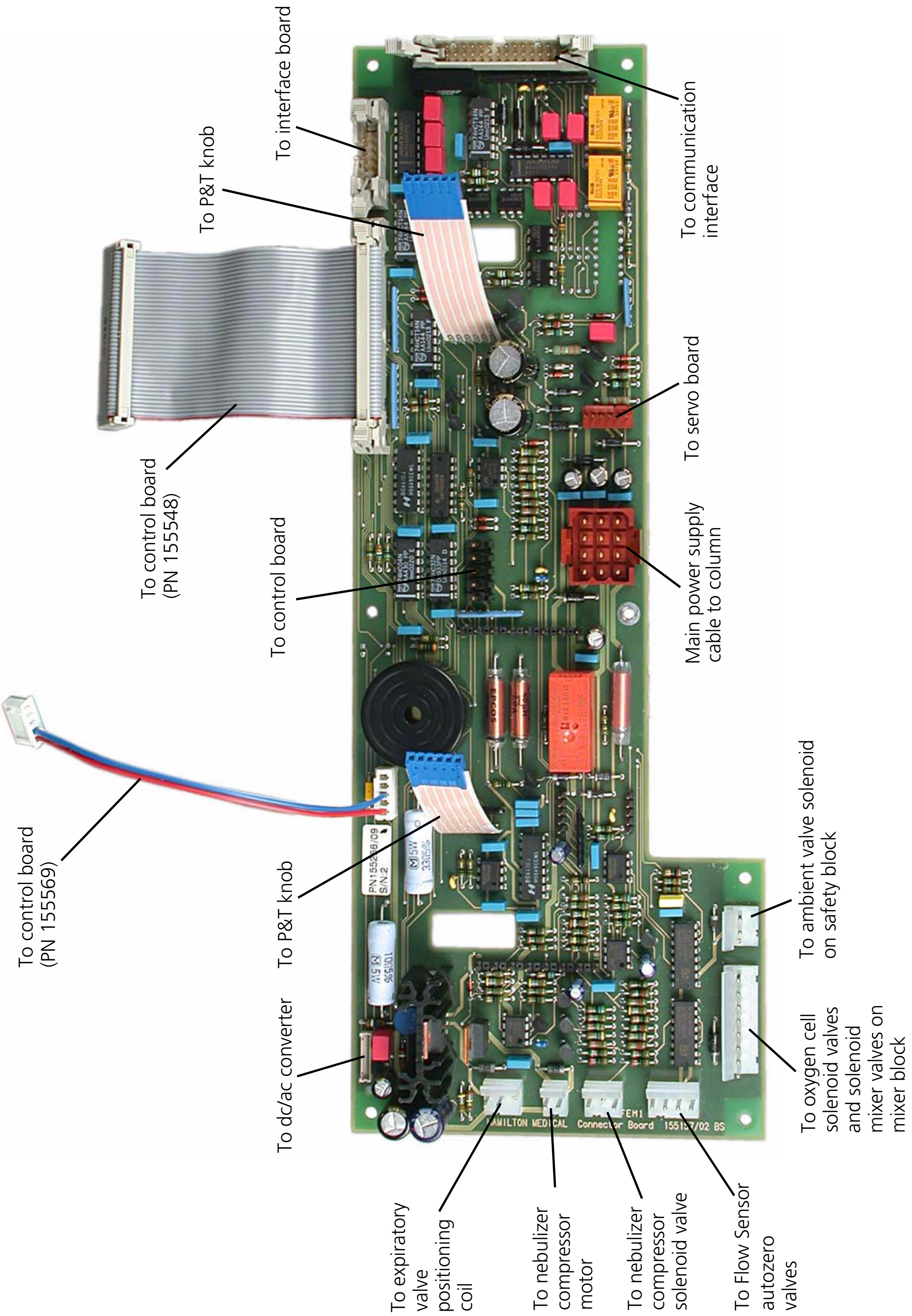


Figure 11-45. **Cable connections to connector board PN 155256 Rev 9 and later**

Testing

WARNING

You must perform all the following tests.

After fitting a new connector board, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
    - Section 9, *Running Original or Upgrade 1 test software*
    - Section 10, *Running Upgrade 2 test software*

11.11 Control board and GMP assembly

CAUTION

Do not attempt to repair the control board or the GMP assembly. (Although you are permitted to change boards on the GMP assembly when upgrading.) HAMILTON MEDICAL AG does not permit anyone to make board-level repairs to GALILEO in the field. If a board is faulty, you must replace it with a new one.

11.11.1 References

- Position in enclosure: Section 3.2, *Components in the front enclosure*, on page 3-2.
- Testing:
  - *TSW 1: GMP Selftest*, on page 9-3.
  - *TSW 2: GPT-GMP Communication*, on page 9-6.
  - *TSW 3: Display*, on page 9-11.
  - *TSW 5: GCP-GMP Communication*, on page 9-19.
  - *TSW 6: A/D Conversion*, on page 9-22
  - *TSW 7: D/A Conversion*, on page 9-25

  Or:
  - *1: Microprocessor checks*, on page 10-4.
  - *2: GPT–GMP communication & LED checks*, on page 10-8.
  - *3: LCD display checks*, on page 10-14.
  - *5: GCP–GMP communication checks*, on page 10-23
  - *6: A/D converter check*, on page 10-26
  - *7: D/A converter check*, on page 10-30
- Part numbers:
  - Control board: PN 155154, shown in Appendix H.7, *Boards*, on page H-5.
  - Control board: PN 155461, shown in Appendix H.7, *Boards*, on page H-6.
  - GMP: PN 155499, shown in Appendix H.7, *Boards*, on page H-6.
  - GMP: PN 396138, shown in Appendix H.7, *Boards*, on page H-7.
  - GMP: PN 396170, shown in Appendix H.7, *Boards*, on page H-7.
  - GMP LCD adaptor: PN 155563, shown in Appendix H.7, *Boards*, on page H-6.

11.11.2 Placement

The control board is located in the front enclosure, on a large metal mounting plate. The *GMP* board is mounted on the control board. Both are shown in Figure 11-46 below, and Figure 3-1, *Components in the front enclosure*, on page 3-2.

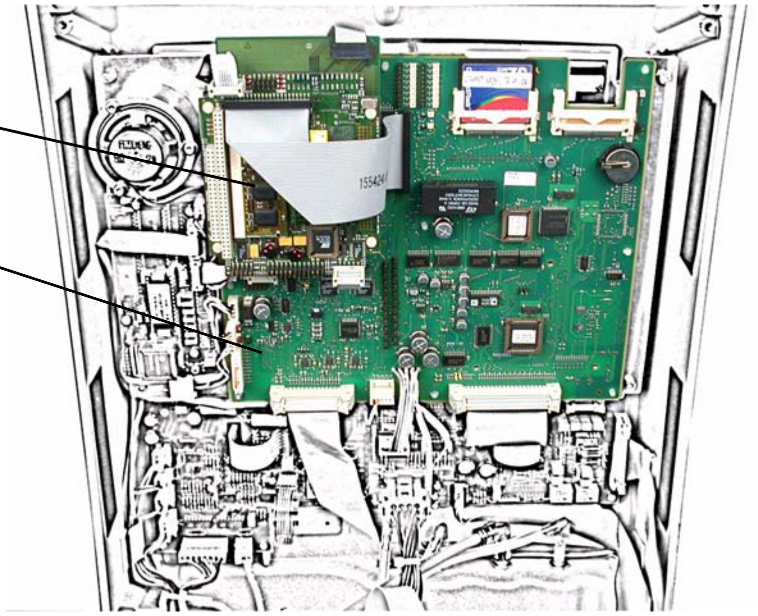


Figure 11-46. Position of the control board and GMP board inside the front enclosure

11.11.3 Purpose

Control board

The purpose of the control board is to:

- Manage inputs and outputs from most parts of GALILEO, including the user interface.
- Act as the main control board (it holds the *GPT* and *GCP*).
- Perform A/D and D/A conversion.
- Perform signal multiplexing.
- Perform analog switching.
- Amplify the audible alarm signal.

GMP assembly

The GMP assembly has two major parts:

- The single-board computer. The purpose of this is to perform most of the signal processing that takes place in GALILEO.
- The graphics controller board. The purpose of this is to manage the LCD display.

11.11.4 Description and function

Control board

There are two major generations of control board:

- PN 155154.
  This is for original and Upgrade 1 GALILEOs (GALILEOs with revision 1 or 2 software), and is shown in Figure 11-47.
- PN 155461.
  This is for Upgrade 2 GALILEOs (GALILEOs with revision 3 software). An early revision is shown in Figure 11-48 on page 11-48 and a later revision including microswitches is shown in Figure 11-49 on page 11-48.

Note
You cannot run revision 3 software unless you have control board PN 155461.

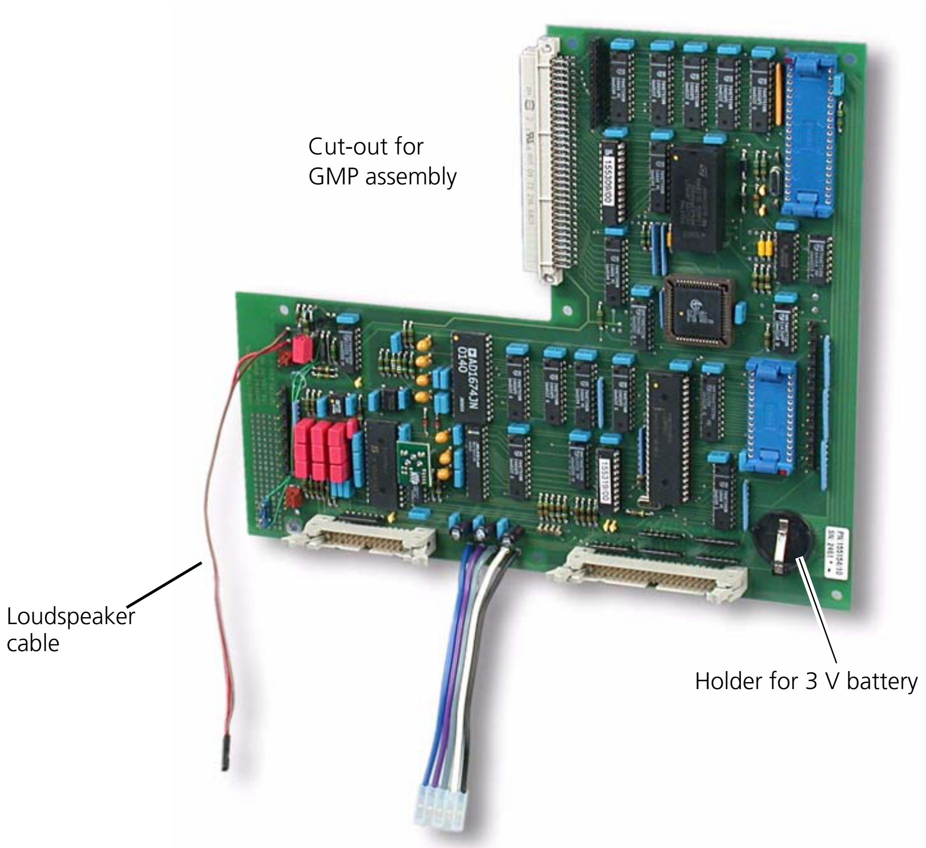


Figure 11-47. Control board PN 155154 for original and Upgrade 1 GALILEOs

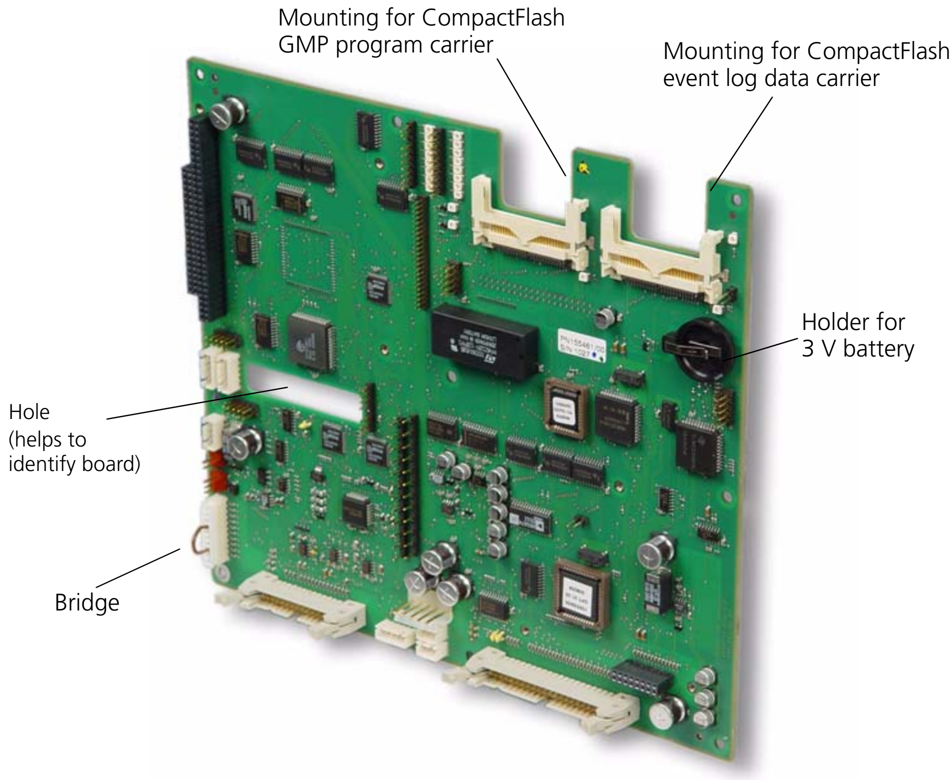


Figure 11-48. Control board PN 155461, early revision, for Upgrade 2 GALILEOs

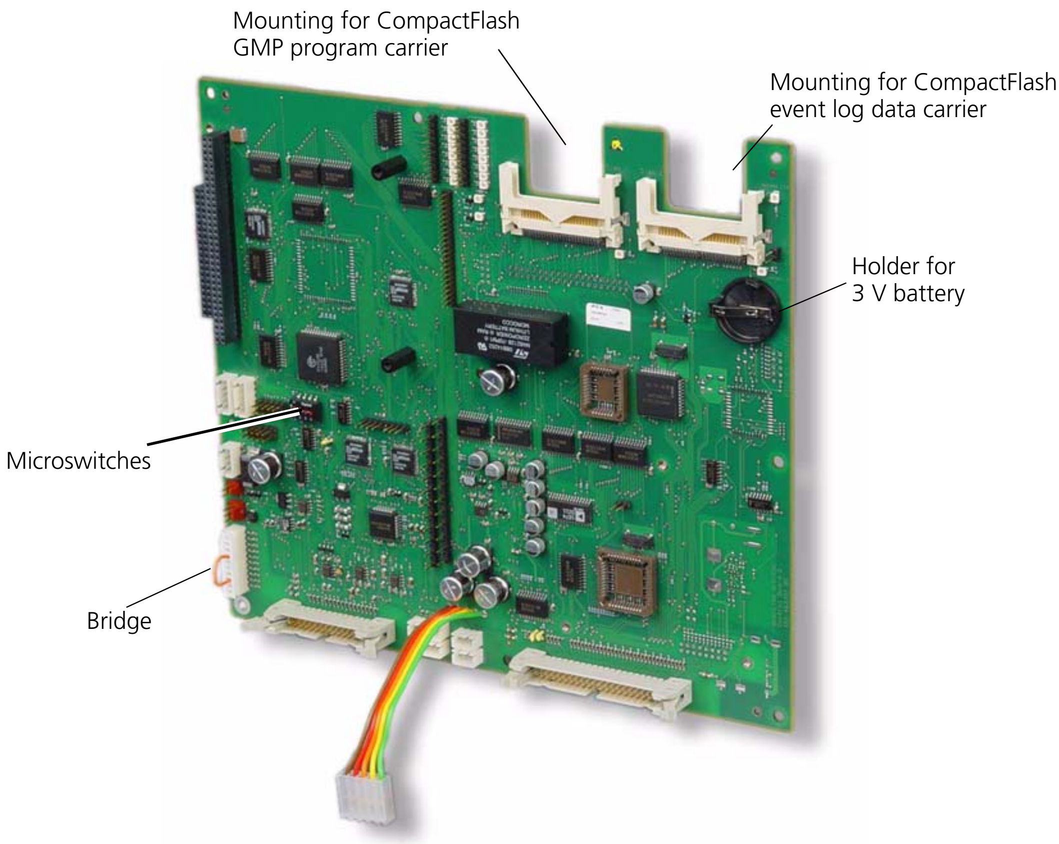


Figure 11-49. Control board PN 155461 Rev 04 and later for Upgrade 2 GALILEOs

The most apparent differences between the two control boards are shown on Table 11-8.

<table>
<tr><th>Feature</th><th>Control board
PN 155154</th><th>Control board
PN 155461
Rev 00 to 03</th><th>Control board
PN 155461
Rev 04 and later</th></tr>
<tr><td>Cut-out for GMP assembly.</td><td>Yes.</td><td colspan="2">No.
(Newer GMP assemblies do not require a cut-out.)</td></tr>
<tr><td>Mountings for CompactFlash data carriers.</td><td>No.
(GMP software CompactFlash mounted directly on GMP.)</td><td colspan="2">Yes.
The mounting on the left is used for the GMP software CompactFlash. The one on the right is optional, and can be used for downloading the event log.</td></tr>
<tr><td rowspan="2">Holder for 3 V battery.</td><td rowspan="2">Yes.
Positioned on lower right-hand corner, unless GMP 155460 is used (in which case, it is positioned in the GMP assembly).</td><td colspan="2">Yes. Positioned on upper right-hand corner.</td></tr>
<tr><td></td><td>Must not be used if GMP CPU module PN 396170 is fitted. This module has its own long-life battery.</td></tr>
<tr><td>White plastic bridge.
(Figure 11-55 on page 11-54.)</td><td>No.
(Permanent wire bridge sometimes in place.)</td><td colspan="2">Yes.
Positioned in lower left-hand corner of board.</td></tr>
<tr><td>Microswitches</td><td>No.</td><td>No.</td><td>Yes.
Positioned below mounting area for GMP.
(For more information, see Microswitch settings for GMP assemblies on page 11-51.)</td></tr>
</table>

Table 11-8. Control board comparison table

GMP assembly

Over the course of GALILEO's production, there have been a number of GMP assemblies produced. Table 11-9 shows the control board/GMP assembly combinations possible.

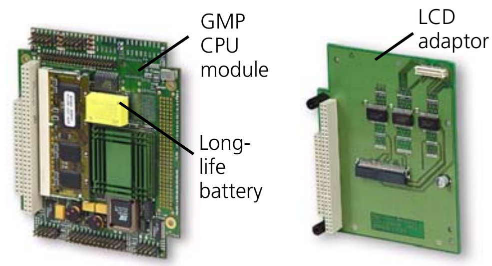
	Control board	GMP assembly	Comment
Original and Upgrade 1 GALILEOs	PN 155154	PN 396138 	GMP assembly PC 96 (including adaptor PN 155313) for original GALILEOs before SN 1933. 3 V battery PN 369069 mounted on control board.
		PN 155460 	For original GALILEOs with SN 1933 and later, and for Upgrade 1 GALILEOs. 3 V battery PN 369069 mounted on GMP assembly.
Upgrade 2 GALILEOs	PN 155461 Rev 00 to 04	PN 155499 	Comprises the upper two boards of PN 155460. 3 V battery PN 369069 mounted on control board. For microswitch settings, see *Microswitch settings for GMP assemblies* on page 11-51.
	PN 155461 Rev 04 and later (Rev 04 can also have GMP PN 155499, as shown above.)	There is no single assembly available. Instead, order one or both of the following parts: • GMP CPU module PN 396170 • GMP LCD adapter PN 155563 • Cable PN 155559 	Does not require 3 V battery PN 369069 to be installed, as long-life battery already installed on GMP CPU module. For microswitch settings, see *Microswitch settings for GMP assemblies* on page 11-51.

Table 11-9. Control board and GMP assembly compatibility

11.11.5 Further information

Troubleshooting

For information about troubleshooting using the control board, see Section 12.3.1, *Control board LED troubleshooting*, on page 12-59.

Microswitch settings for GMP assemblies

On control board PN 155461 Rev 04 and later, the microswitches located immediately under the GMP assembly (Figure 11-50) must be set appropriately for the type of GMP assembly mounted on the control board.

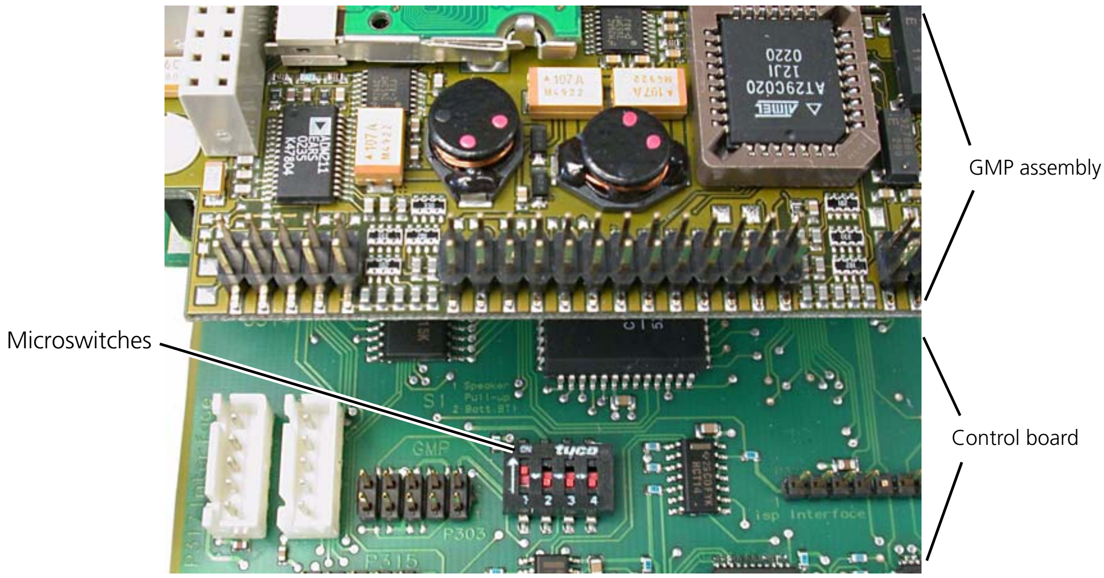


Figure 11-50. Position of microswitches on control board PN 155461

When using GMP assembly PN 155499 make sure the microswitch settings are as follows:

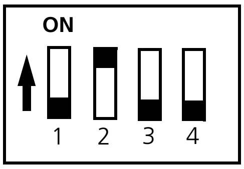


Figure 11-51. Microswitch settings for GMP assembly 155499

When using GMP CPU module PN 396170 together with GMP LCD adapter PN 155563, make sure the microswitch settings are as follows:

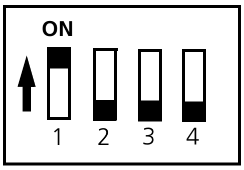


Figure 11-52. Microswitch settings for GMP CPU module PN 396170

The function of the microswitches is shown in Table 11-10:

Switch	Function	Comment
1	Loudspeaker.	Switch must be set appropriately for loudspeaker to function.
2	3 V clock battery on control board.	• When using control board PN 155461 Rev 04 and GMP CPU module PN 396170, switch 2 must be set to off. GALILEO then uses the life-long 3 V battery on the GMP CPU module. In this case, it is not necessary to mount a 3 V battery on the control board. • With control board PN 155461 Rev 05 and later, switch 2 has no function.
3	Unused.	
4	Unused	

Table 11-10. Control board microswitch functions

11.11.6 Replacing the control board and GMP assembly

The following procedure shows you how to remove both the *control board* and the GMP assembly together. It is unlikely that you must replace the control board, except in the event of a major product update.

Note
If you want to replace GMP module PN 155499, go to

Removing the control board complete with GMP assembly

1. Open GALILEO's main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
2. Locate the control board and GMP assembly. (Figure 11-46 on page 11-46.)
3. Remove all cable connectors joining the control board and the GMP board to other parts of the GALILEO.

   Note
   Never pull a connection apart by pulling on a cable. Always hold the connector. If necessary, use pliers or prise the connection apart with a screwdriver.

4. Remove the single grounding (earthing) screw securing the control board to the aluminium mounting plate. (Figure 11-53.)

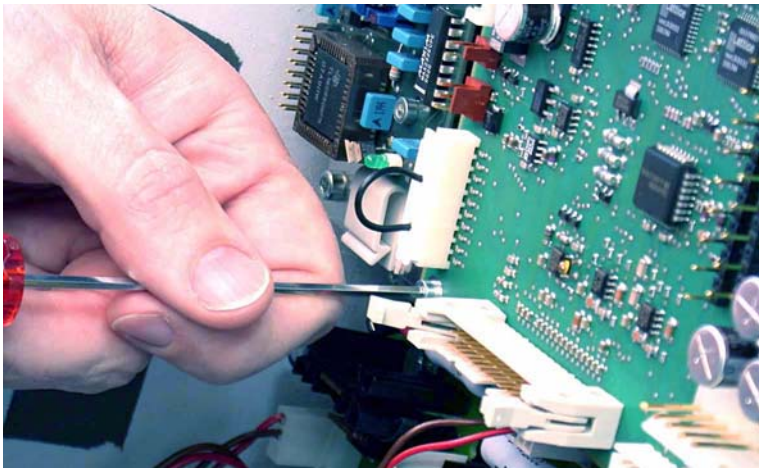


Figure 11-53. Removing the grounding screw

5. Remove the control board from the plastic spacers. Do do this, squeeze each spacer in turn, while easing the board off the spacer. Leave the spacer in the center of the board until last. (Figure 11-54.)

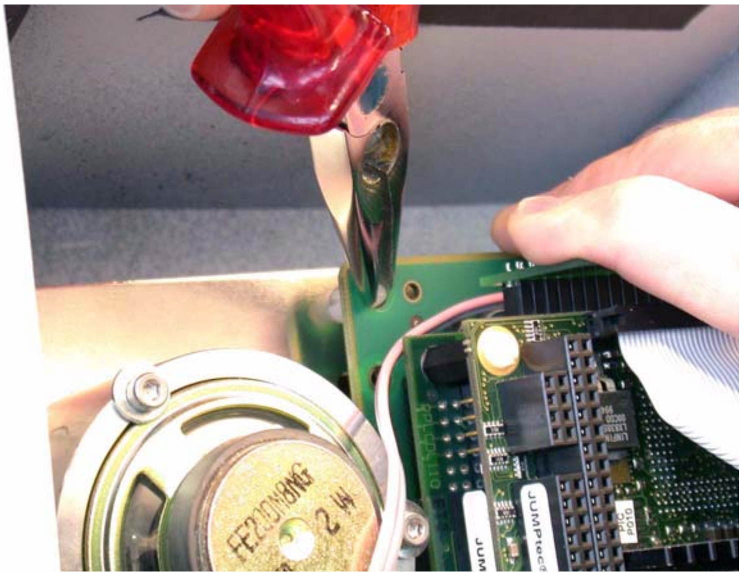


Figure 11-54. Removing the board from one spacer

Fitting the new control board

To fit the new control board, you basically reverse the removal procedure. However, note the following points:

- To remount the control board, you must only press it onto the plastic spacers. You do not require pliers.
- Make sure that you attach all cables correctly. (Figure 11-56 and Figure 11-57.)

- Make sure that the white plastic bridge is in place on the bottom left-hand corner of the new board. You might have to move it from the old board. (Figure 11-55 and Figure 11-56.)

Figure 11-55. The white plastic bridge

- The two almost identical cables to the servo board and the sensor board (Figure 11-56) supply power. The longer (PN 155506) is connected to the sensor board, the shorter (PN 155504) to the servo board. You can plug either cable into either of the two sockets on the control board.

Note

Both Figure 11-56 and Figure 11-57 show a revision of control board PN 155461 earlier than Revision 04. There are no microswitches immediately below the GMP assembly, and the latest version of the assembly (GMP CPU module PN 396170 and GMP LCD adapter PN 155563) is not fitted.

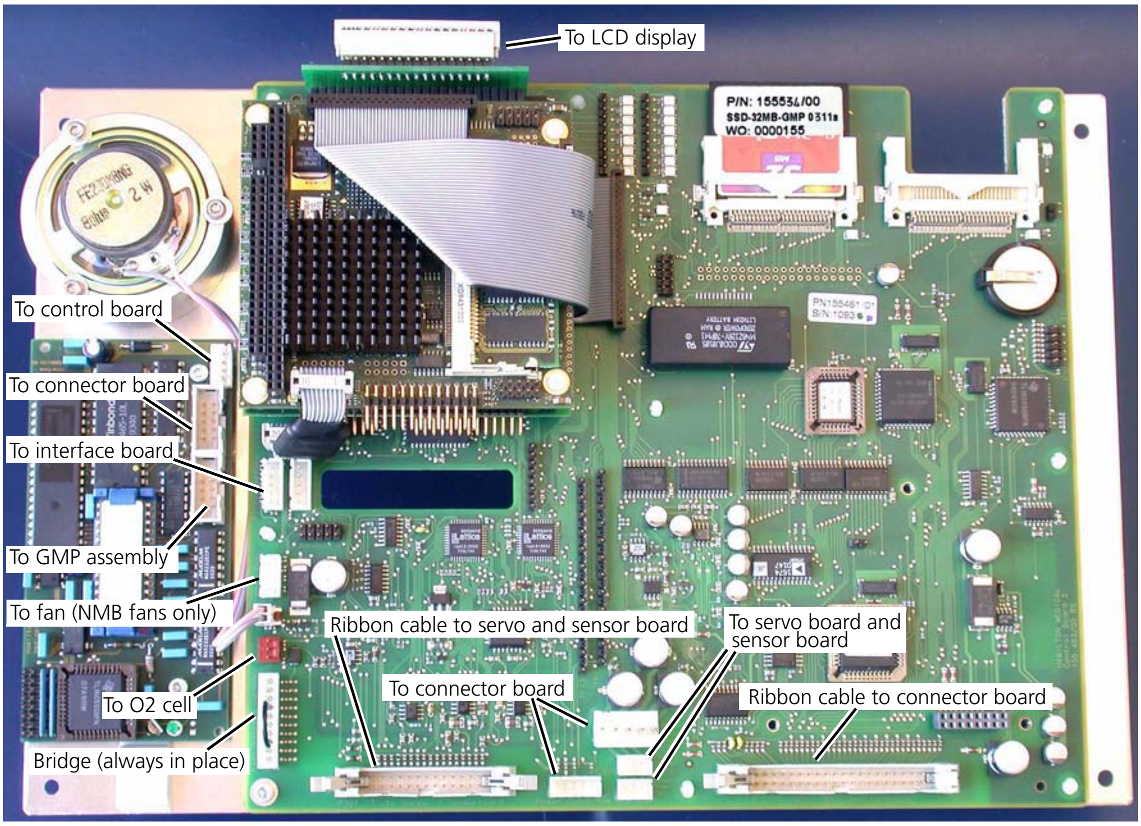


Figure 11-56. Control board PN 155461 connections

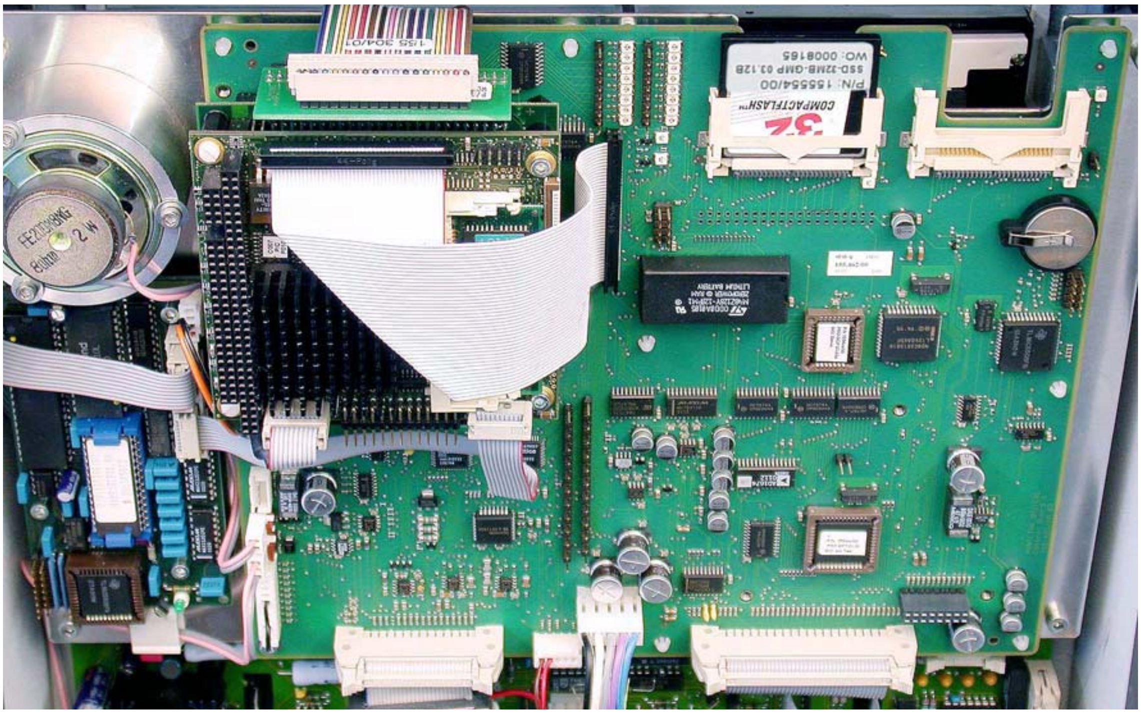


Figure 11-57. **Control board PN 155461 in GALILEO, with all connections in place**

Testing

WARNING

You must perform all the following tests.

After fitting a new control board, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
  - Section 9, *Running Original or Upgrade 1 test software*
  - Section 10, *Running Upgrade 2 test software*

11.11.7 Replacing GMP CPU module PN 396170 and LCD adaptor PN 155563

11.11.7.1 Introduction

This section deals with replacing the newest GMP unit comprising CPU module PN 396170 and LCD adaptor PN 155563.

Note

For information about any other kind of GMP replacement, contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

11.11.7.2 Ordering parts

Order the parts shown in Figure 11-11.

To order	
CPU module PN 396170.	
LCD adaptor PN 155563.	
Latest version 3.* GMP software recommended.	For latest information, see the HAMILTON MEDICAL AG Partner Website (http://www.hamilton-medical.ch/partner-site).
Latest version 3.* GCP software recommended.	
Latest version GIP software recommended.	
You already have the GPT software installed.	Use the GPT software you have installed.

Table 11-11. Items to order

11.11.7.3 Procedure

Removing the old GMP assembly

1. Open GALILEO's main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
2. Make sure that the 3 V battery connectors are not touching. (Figure 11-35 on page 11-30.)
3. Remove all cables connected to the CPU module and the LCD adaptor (the GMP assembly).

Note
Do not remove the cables from other boards. Only remove them from the GMP assembly.

4. Remove the two boards comprising the GMP assembly.

5. Remove from the two boards:
   - Two white plastic screws, M3, 25 mm, PN 420585. (Figure 11-58.)
   - Two cylindrical black plastic spacers, PN 257053. (Figure 11-58.)
   - Four grey plastic screws, M3, 5 mm, PN 420573. (Figure 11-59.)
   - Two hexagonal black plastic spacers, PN 257057. (Figure 11-59.)

Figure 11-58. Screw PN 420585 and spacer PN 257053

Figure 11-59. Screw PN 420573 and spacer PN 257057

Fitting the new GMP assembly

Note
The fitting of the new boards is an exact reversal of the removal procedure.

1. Remove cable PN 155559 from the old boards, and fit it between the new CPU module and the new LCD adaptor. (Figure 11-60.)

Figure 11-60. Cable PN 155559 fitted to CPU module and LCD adaptor

2. Push the pins on the CPU module into the LCD adaptor. (Figure 11-61.)

Figure 11-61. Fitting the CPU module and LCD adaptor together

3. Apply the four grey plastic screws, PN 420573, and the two hexagonal spacers, PN 257057, to secure the pin connection. (Figure 11-61.)

Figure 11-62. The screws and spacers in place

4. Apply the two white plastic screws, PN 420585, and the two cylindrical black plastic spacers, PN 257053, that you removed from the old GMP, to the other side of the new GMP assembly. (Figure 11-63.)

Figure 11-63. The screws and spacers in place

5. Screw the new GMP into place, and fit all the cables.

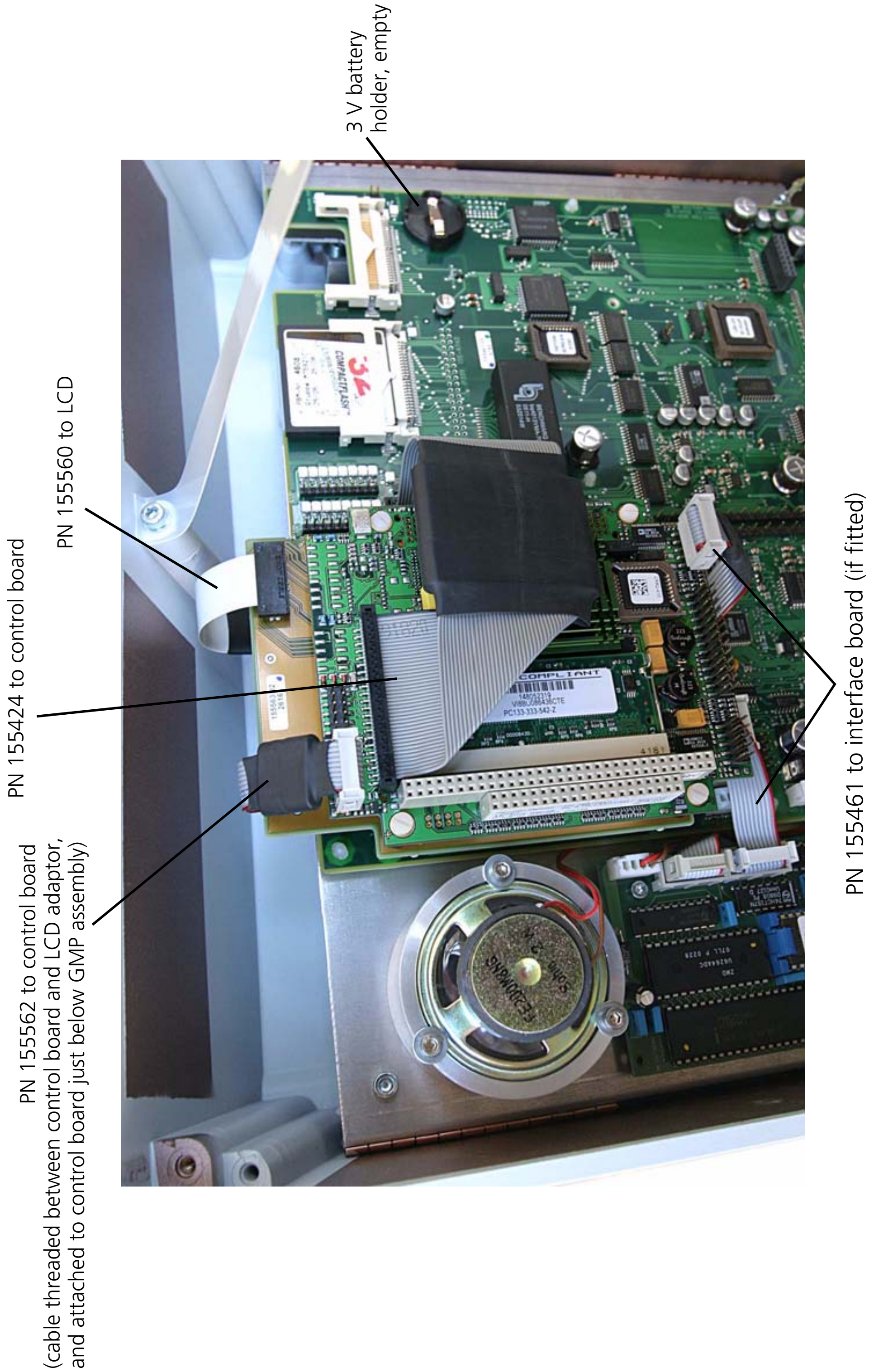


Figure 11-64. Cables, CPU module, in place

Testing

WARNING

You must perform all the following tests.

After fitting a new GMP, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- Section 10, *Running Upgrade 2 test software*

11.12 dc/ac board

CAUTION

Do not attempt to repair the dc/ac board. HAMILTON MEDICAL AG does not permit anyone to make board-level repairs to GALILEO in the field. If a board is faulty, you must replace it with a new one.

11.12.1 References

- Position in enclosure: Section 3.2, *Components in the front enclosure*, on page 3-2.
- Testing:
  - TSW 3.4, *Performing the LCD display color checks*, on page 9-12.

  Or:
  - Unit 3.4, *Performing the LCD display color checks*, on page 10-15.
- Part numbers:
  - PN 155317, shown in Appendix H.9, *LCD display components*, on page H-7.
  - PN 155415, shown in Appendix H.9, *LCD display components*, on page H-7.

11.12.2 Placement

The *dc/ac board* is positioned under the control board in the front enclosure. To see it, you must remove the control board. The dc/ac board is shown (with the control board removed) in Figure 11-65 below, and in the exploded diagram in Figure 3-1, *Components in the front enclosure*, on page 3-2.

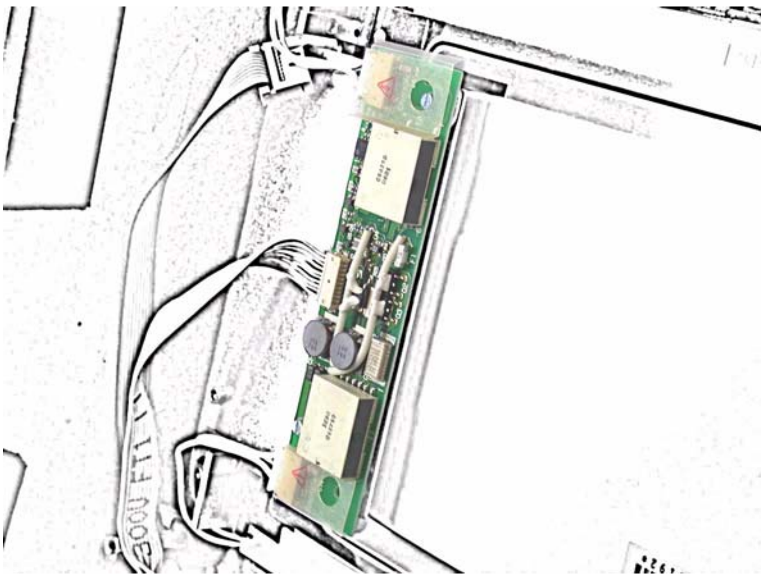


Figure 11-65. **Position of the dc/ac board on LCD display inside the front enclosure**

11.12.3 Purpose

The purpose of the dc/ac board is to provide a high voltage to light up the LCD display.

WARNING

Output from the ac/dc board is approximately 1700 V unloaded.

11.12.4 Description and function

During the course of GALILEO production, two versions of the dc/ac board were used:

- PN 155317 (Hitachi)
- PN 155415 (TDK)

Each board requires its own cable for the connection to the connector board, as shown in Figure 11-66 and Figure 11-67:

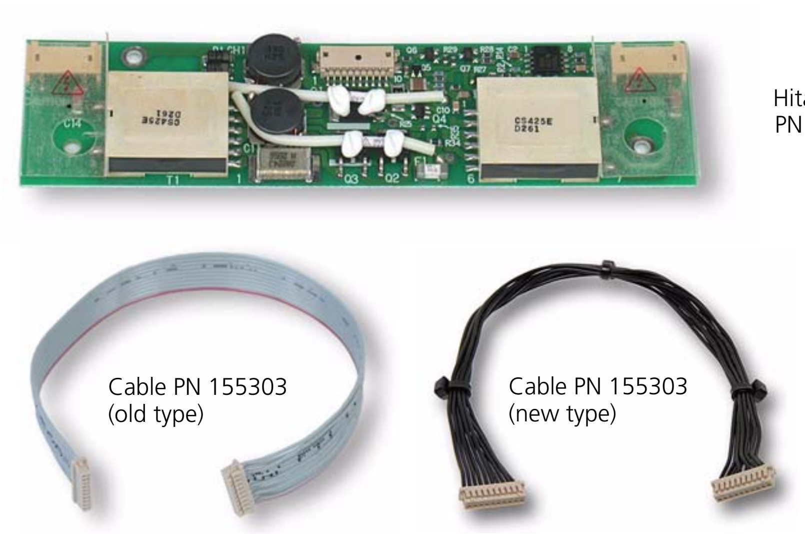


Figure 11-66. Hitachi dc/ac board and matching cable

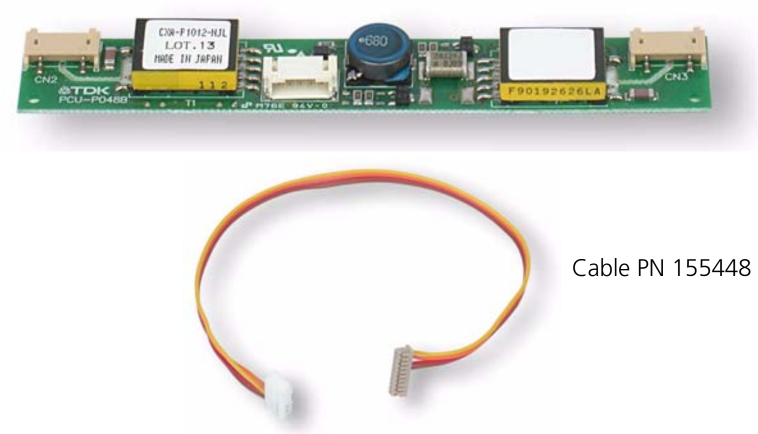


Figure 11-67. TDK dc/ac board and matching cable

11.12.5 Replacing the dc/ac board

Removing the dc/ac board

1. Remove the control board, as documented in *Removing the control board complete with GMP assembly* on page 11-52.
2. Locate the AC/DC converter board. (Figure 11-68.)

Figure 11-68. **The two versions of the dc/ac board, PN 155317 (left) and PN 155415 (right)**

3. Remove the mounting plate supporting the dc/ac board. It is supported by two hexagonal-drive (Allen) screws.
4. Remove the dc/ac board from the mounting plate, being careful not to loose the two plastic spacers.

Fitting the new dc/ac board

To fit the new dc/ac board, reverse the removal procedure.

Make sure to correctly attach all cables to the control board. This is illustrated in Figure 11-56, *Control board PN 155461 connections* and Figure 11-57, *Control board PN 155461 in GALILEO, with all connections in place*, on page 11-55.

Testing

WARNING

You must perform all the following tests.

After fitting a new dc/ac board, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
  - Section 9, *Running Original or Upgrade 1 test software*
  - Section 10, *Running Upgrade 2 test software*

11.13 Expiratory valve

CAUTION

Do not attempt to repair the expiratory valve. HAMILTON MEDICAL AG does not permit anyone to make any repairs in the field at a level lower than the smallest parts provided in Appendix H, *Spare parts*.

11.13.1 References

- Position in gas flow:
  - Section 2.2, *Components managing the principle gas flow*, on page 2-2.
  - Section 2.5, *Components managing the ambient state gas flow*, on page 2-14.
- Testing and calibrating:
  - TSW 15: , *Expiration Valve*, on page 9-70.

  Or:
  - Test 15, *Expiration valve calibrat. & check*, on page 10-83.
- Part numbers: PN 155169, PN 151228, and PN 151233, shown in Appendix H.10, *Valves and assembly groups*, on page H-8.

11.13.2 Placement

The expiratory valve is mounted at the bottom of the chassis, in front of the tank. Only part of the valve — the positioning coil — is located inside GALILEO, as shown in Figure 11-69 below. The other parts are positioned outside the enclosure, as shown in Figure 11-70 below, and in Figure 2-1, *Components managing the principle gas flow*, on page 2-2.

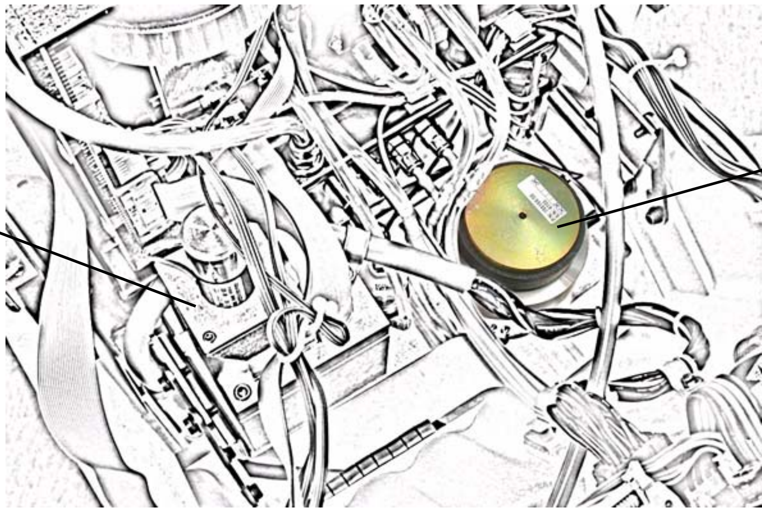


Figure 11-69. Position of the expiratory valve at the bottom of the rear enclosure

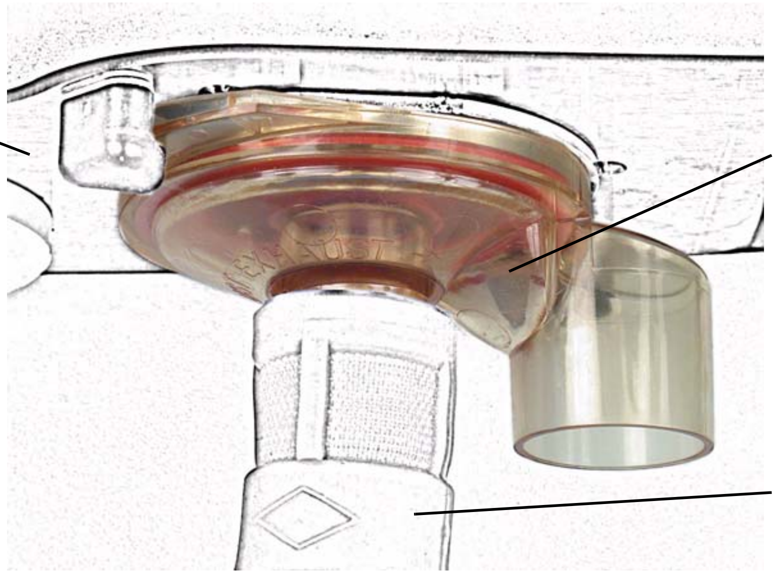


Figure 11-70. Position of the expiratory valve outside GALILEO

11.13.3 Purpose

The purpose of the *expiratory valve* is to:

- Enable gas to escape from the patient breathing circuit in a controlled manner, so as to allow the patient to exhale
- Maintain PEEP/CPAP, if required

To do this, the action of the expiratory valve is closely synchronized with that of the *inspiratory (servo) valve*.

For information about gas flow through the expiratory valve in the context of the complete pneumatic system, see Section 2.2, *Components managing the principle gas flow*, on page 2-2.

11.13.4 Description and function

The expiratory valve (Figure 11-71) comprises:

- A positioning coil, located inside GALILEO, that controls the opening of the valve. (PN 155169.)
- A silicone membrane. (PN 151233.)

- A plastic cover that includes the from-patient port and the exhaust port. This is located on the outer casing of GALILEO. (PN 151228.)

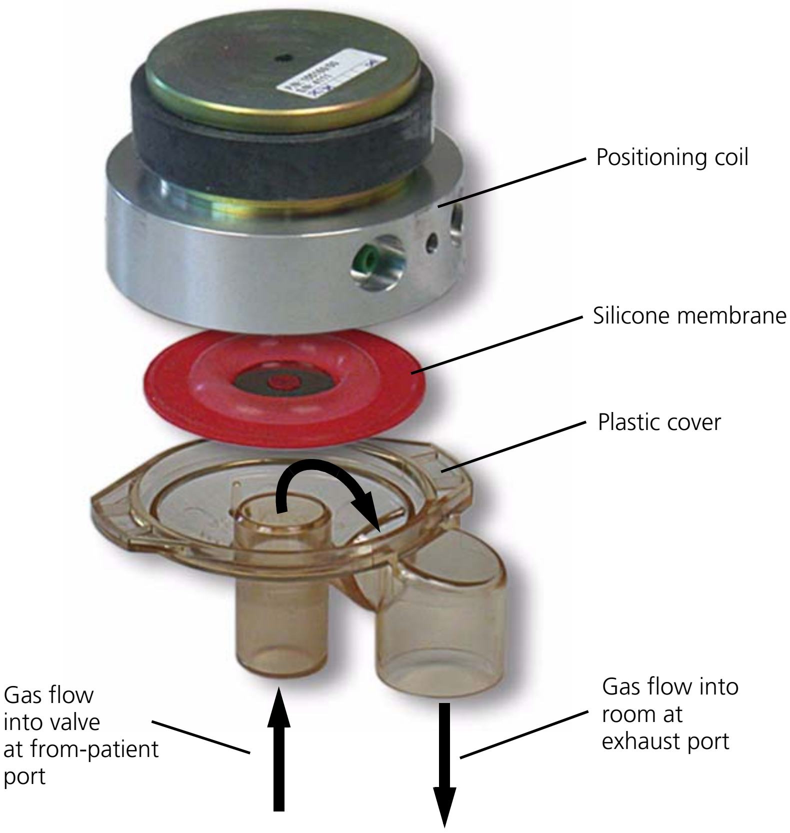


Figure 11-71. The expiratory valve

The metal plunger of the positioning coil applies pressure to the center of the silicone membrane, as shown in Figure 11-72. This controls the flow of gas through the from-patient port orifice.

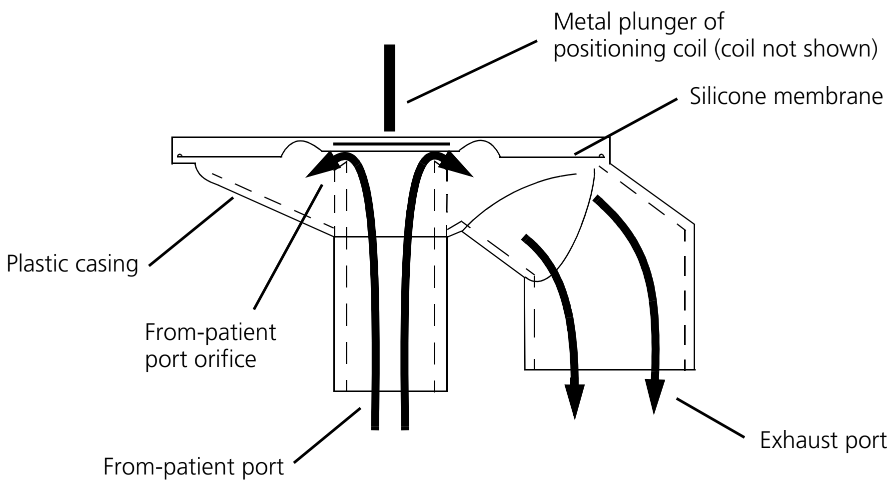


Figure 11-72. Gas flow through the expiratory valve: valve open

The valve has three states:

- Open: The plunger applies no force to the valve membrane. The membrane is completely released from the expiratory valve cover to allow complete exhalation.
- PEEP/CPAP: The plunger applies the required force to the valve membrane. The patient pressure can fall no lower than the required PEEP/CPAP value.
- Closed: The plunger applies full force to the valve membrane. Exhalation gases cannot pass through the valve.

Note
When the positioning coil is passive (unpowered) the expiratory valve is always open. This means that even in the event of complete system failure, when there is no power available, the patient can inspire through the ambient valve (if he has the ability to breathe unaided), and expire freely through the expiratory valve.

11.13.5 Further information

The unique design of the expiratory valve allows expired gas to pass through the valve and into the room without entering the body of GALILEO. Therefore, by replacing the patient tubing, the plastic valve body, and the membrane, you replace all the parts with which expiratory gases come into contact.

The expiratory valve membrane and cover are easy to maintain, and are autoclavable. The operators' manuals give details of sterilizing procedures.

You calibrate and check the inspiratory valve in Test 14, *Servo and Flow Sensor*, on page 9-63 or Test 14, *Inspiration valve check*, on page 10-75, depending on which software version you have.

WARNING

- **Never attach a spirometer or any other device or tube to the exhaust port as this can cause GALILEO to lose full control of PEEP/CPAP.**
- **When attaching the silicone membrane, make sure it is positioned as shown in Figure 11-71 on page 11-66.**

11.13.6 Replacing the expiratory valve positioning coil

Note
Expiratory gases from the patient do not enter GALILEO, and never come into contact with the expiratory valve positioning coil. For this reason, it is only necessary to sterilize the expiratory valve membrane and cover, and the patient tubing between patients.

Removing the expiratory valve positioning coil

To remove the positioning coil, do the following:

1. Open GALILEO's main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
2. Locate the positioning coil. (See Section 11.13.2, *Placement*, on page 11-64.)

3. Remove the expiratory valve cover and membrane. (Figure 11-73.)

Figure 11-73. Removing the expiratory valve cover and membrane

4. Rotate the exposed metal collar until you have access to one of the three screws that secure the expiratory valve to the chassis. (Figure 11-74.)

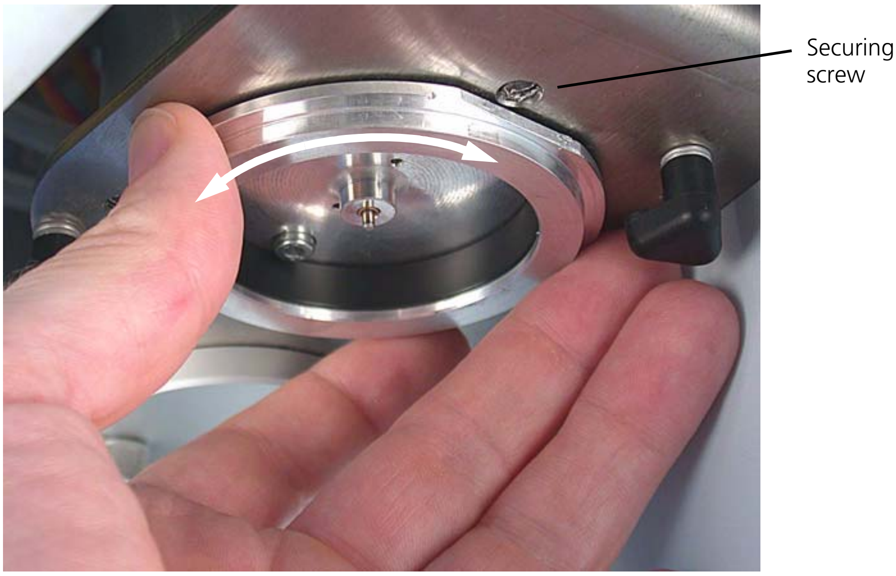


Figure 11-74. Rotating the metal collar

5. Remove the screw. (Figure 11-75.)

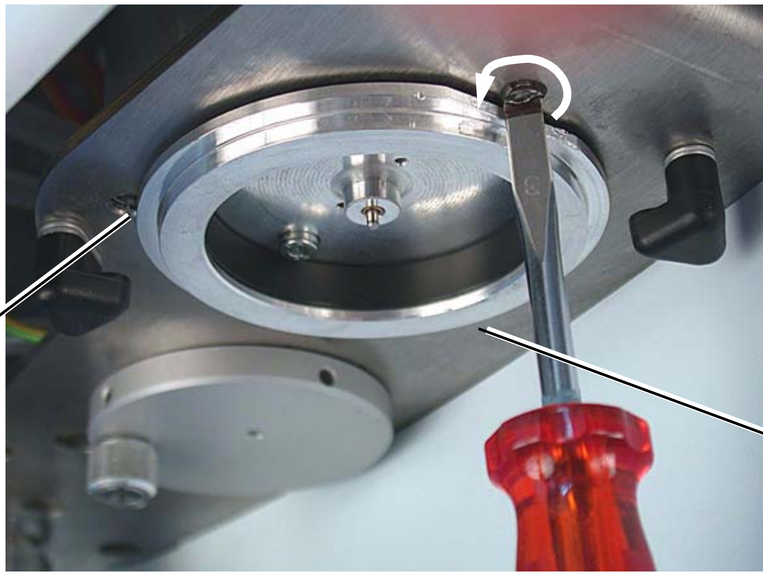


Figure 11-75. Removing the first screw securing the expiratory valve

6. Remove the second and third securing screws in a similar way. (Figure 11-75.)
7. Lift the expiratory valve positioning coil from the chassis, and remove the wires connecting to the coil.

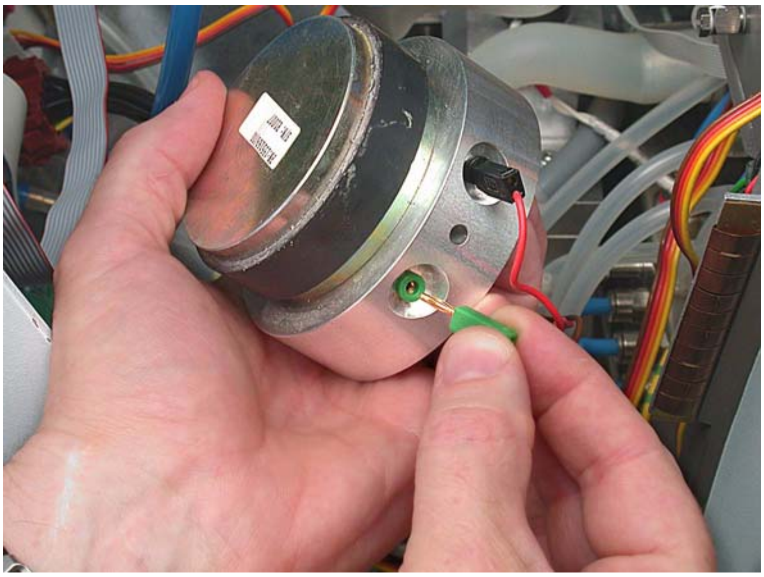


Figure 11-76. Removing the expiratory valve positioning coil

Fitting the new positioning coil

Fitting the new positioning coil is simply a reversal of the removal procedure.

Testing

WARNING

You must perform all the following tests.

After fitting a new positioning coil, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
    - Section 9, *Running Original or Upgrade 1 test software*
    - Section 10, *Running Upgrade 2 test software*

11.14 Fan

CAUTION

Do not attempt to repair the fan. HAMILTON MEDICAL AG does not permit anyone to make any repairs in the field at a level lower than the smallest parts provided in Appendix H, *Spare parts*.

11.14.1 References

- Position in enclosure: Section 3.3, *Components in the rear enclosure*, on page 3-8.
- Testing: There is no special test for the fan.
- Maintenance: Section 5, *Hospital preventive maintenance*.
- Part numbers: PN 155230 and PN 155423, shown in Appendix H.19, *Miscellaneous*, on page H-22.

11.14.2 Placement

The fan is positioned at the top of GALILEO's rear enclosure, as shown below in Figure 11-77, and in Figure 3-2, *Miscellaneous components and features in the rear enclosure*, on page 3-8.

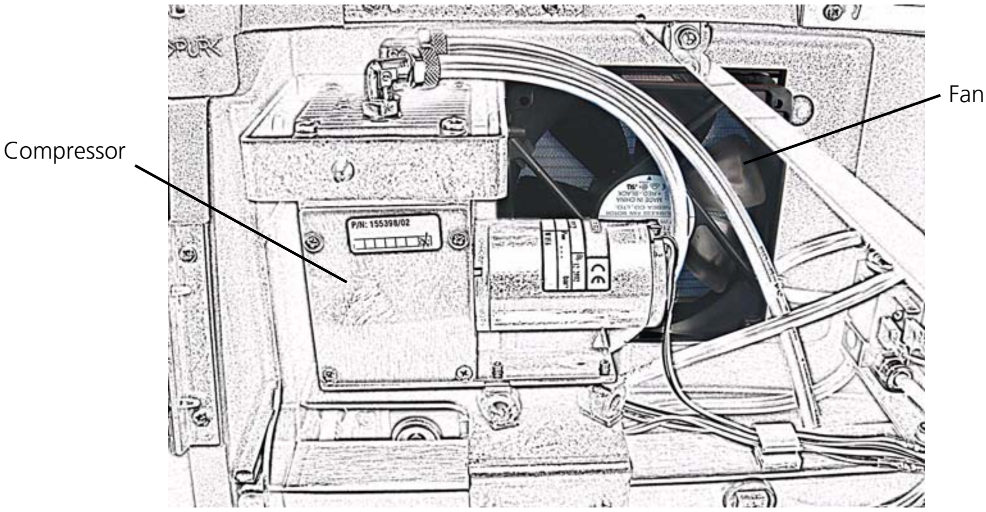


Figure 11-77. The position of the cooling fan from inside GALILEO

11.14.3 Purpose

The purpose of the fan is:

- To prevent oxygen accumulating inside GALILEO, and thereby avoid the risk of explosion.
- To provide cooling to the electrical circuits.

11.14.4 Description and function

The fan draws room air through a filter, and blows it into GALILEO. The air circulating inside GALILEO is therefore always clean.

There are three versions of the fan:

- PN 155230.
  This is for original GALILEOs, factory Upgrade 1 GALILEOs, and for field-upgraded Upgrade 2 GALILEOs. It plugs into the *servo board*, and is labelled PAPST.
- PN 155423. Original version.
  This is for factory Upgrade 2 GALILEOs. It plugs into the *control board* and is labelled NMB. It is similar to PN 155230, but has a much longer cable to enable it to reach the control board.
- PN 155423. New version used from September 2005.
  This is the same as PN 155423 original version, but has curved blades for quieter operation. (Figure 11-78).

Figure 11-78. Original (left) and new (right) versions of fan PN 155423

11.14.5 Further information

As with many parts of GALILEO, the fan is monitored by the alarm system. Electrical failure or physical mechanical interruption causes an alarm. (For example, technical fault *5513* on page 12-26.)

CAUTION

Do not disconnect the fan while GALILEO is running.

11.14.6 Maintenance

Note

Make sure that the fan filter is regularly washed by hospital staff, as indicated in Section 6, *Engineer preventive maintenance*. If the filter is not clean, wash or replace it yourself, and remind hospital staff of the need to perform this task.

11.14.7 Replacing the fan

Removing the fan

1. Open GALILEO's main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
2. Unplug the fan.

   If you have fan PN 155230, labelled PAPST (Upgrade 1 and original GALILEOs) you unplug it from the servo board, as shown in Figure 11-79.

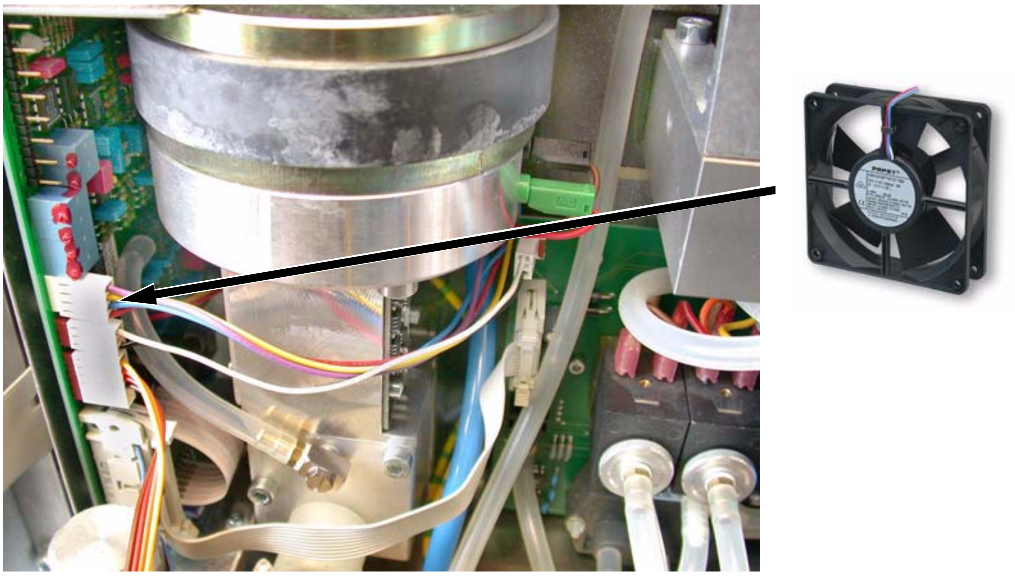


Figure 11-79. Fan PN 155230 plugs into the servo board

If you have fan PN 155423, labelled NMB (Upgrade 2 GALILEOs) you unplug it from the control board, as shown in Figure 11-80.

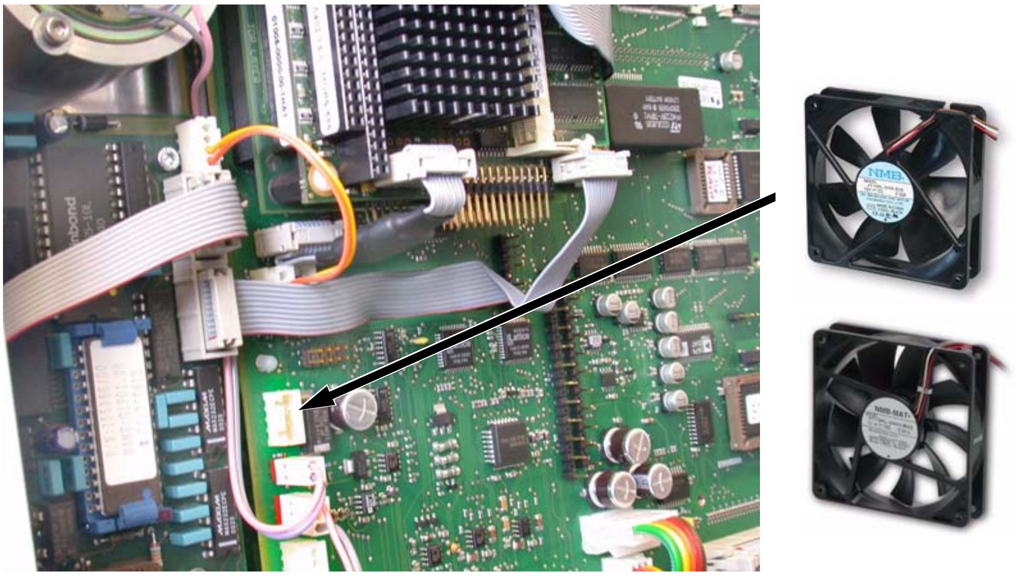


Figure 11-80. Fan PN 155423 plugs into the control board (old version shown above, new version below)

3. Remove the fan cover and fan filter from the rear enclosure. You do this by taking a firm grip with your fingers, and pulling. (Figure 11-81.)

Figure 11-81. Removing the fan filter and cover

4. Remove the four hexagonal-drive (Allen) screws securing the fan. (Figure 11-82.)

Figure 11-82. Removing the hexagonal-drive (Allen) screws securing the fan

5. Remove the grounding (earthing) connection. (Figure 11-83.)

Figure 11-83. Removing the grounding connection.

6. Remove the fan, complete with the screen that supports the filter.

Separate the screen from the fan by removing the screws indicated. (Figure 11-84.)

Figure 11-84. Fan PN 155423 (old version), complete with screen

Fitting the new fan

Fitting the new fan is simply a reversal of the removal procedure. Make sure that you secure the cable using the appropriate cable grips.

Note

If you are replacing an old-model fan (PN 155230) with a new-model fan (PN 155423) in a GALILEO that has been upgraded in the field to Upgrade 2 (software revision 3), you unplug the old fan from the servo board (Figure 11-79 on page 11-73) but must plug the new fan into the control board (Figure 11-80 on page 11-74).

Testing

WARNING

You must perform all the following tests.

After fitting a new fan, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
  - Section 9, *Running Original or Upgrade 1 test software*
  - Section 10, *Running Upgrade 2 test software*

11.15 Flow Sensor

CAUTION

Do not attempt to repair a Flow Sensor. HAMILTON MEDICAL AG does not permit anyone to make any repairs in the field at a level lower than the smallest parts provided in Appendix H, *Spare parts*.

11.15.1 References

- Position in enclosure:
  - Section 2.3, *Components performing principle pressure and flow measurements*, on page 2-6.
  - Section 2.4, *Components managing the patient and tank overpressure-relief gas-flows*, on page 2-12
  - Section 2.5, *Components managing the ambient state gas flow*, on page 2-14
- Testing and calibrating:
  - TSW 14.5, *Performing the Flow Sensor calibration*, on page 9-65.

  Or:
  - Unit 14.5, *Performing the Flow Sensor calibration*, on page 10-79.
- Part numbers: PN 155500, PN 279362, and PN 279331, as shown in the HAMILTON MEDICAL *Product Catalog* (PN 689060).

11.15.2 Placement

The Flow Sensor is positioned in the spur that delivers gas from the patient circuit to the patient and returns expiratory gases from the patient to the patient circuit. There is a two-way flow of gases in the spur. Gas flows in one direction only around the patient circuit.

The position of the Flow Sensor is shown in Figure 11-85.

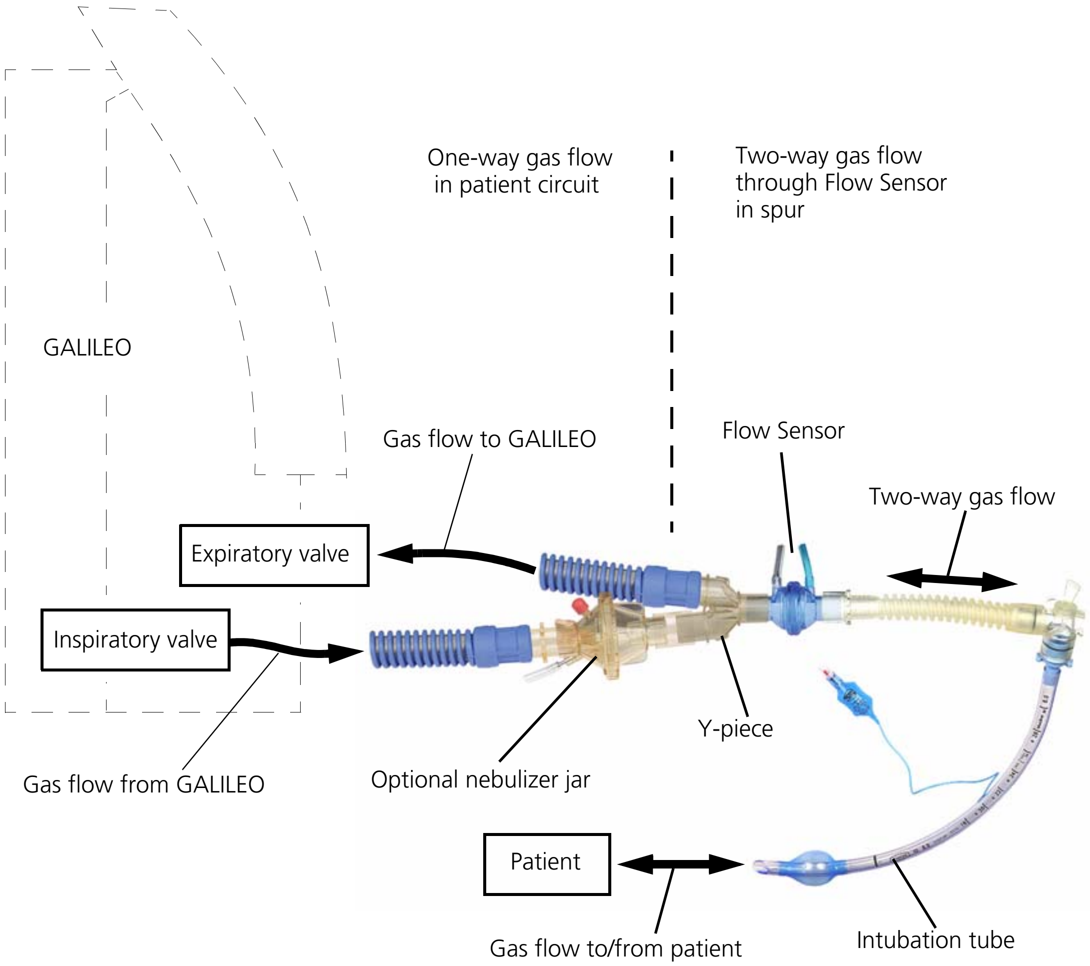


Figure 11-85. The position of the Flow Sensor

11.15.3 Purpose

The purpose of the Flow Sensor is to enable GALILEO to:

- Determine gas flow to and from the patient at a point proximal to (very close to) the patient's airway.
- Measure gas pressure at a point proximal to the patient's airway.

GALILEO is not totally dependent on the Flow Sensor. In the event of a malfunction of the Flow Sensor, ventilation of the patient is continues. However, in this case, the flow trigger cannot function, and GALILEO automatically switches to pressure trigger mode.

The Flow Sensor does not measure gas flow directly. GALILEO calculates flow through the Flow Sensor based on the readings of pressure sensors inside GALILEO that are connected to the Flow Sensor.

11.15.4 Description and function

Types of Flow Sensor

There are three types of Flow Sensor: infant, single-use, and reusable (although not all are available in all countries). They are very similar in appearance, and the principles on which they function are identical. (Figure 11-86.)

PN 155500 infant, single-use

PN 279362 pediatric/adult, reusable

PN 279331 pediatric/adult single-use

Figure 11-86. The three Flow Sensors available

Construction and operation of Flow Sensors

The following description applies to all kinds of Flow Sensor.

The Flow Sensor is a plastic module comprising two chambers. The chambers are separated by a plastic membrane into which a flexible, variable orifice is cut. (Figure 11-87.)

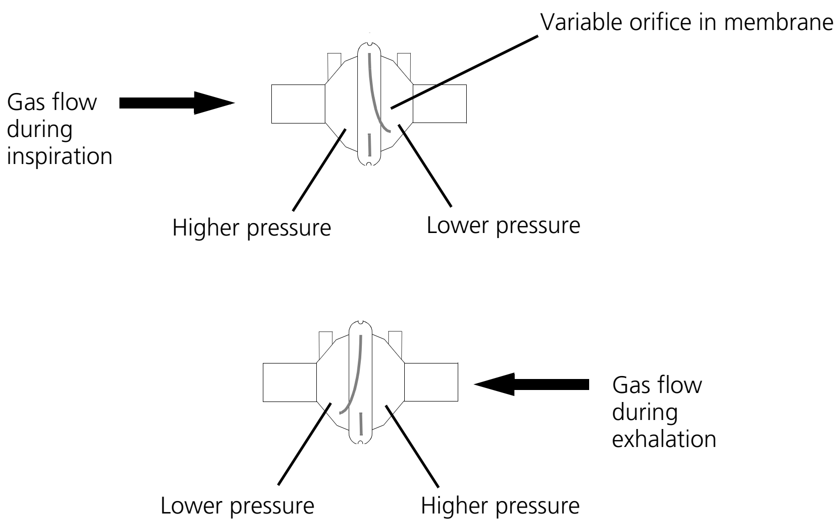


Figure 11-87. Operation of the Flow Sensor

The movement of airway gases during respiration causes pressure differences between the two chambers of the Flow Sensor. (Figure 11-87.) These differences are increased by the resistance of the variable orifice, which has its strongest effect at the low gas flows that are otherwise most difficult to accurately measure.

Because there is a known relationship between the pressure difference between the two chambers and the rate of flow of gas through the Flow Sensor, it is possible for GALILEO to calculate both the rate and the direction of flow by measuring the pressure difference between the two chambers.

For GALILEO to measure the pressure difference between the chambers, each chamber in the Flow Sensor is connected to GALILEO by a length of small-diameter tubing. One tube is blue (patient side), and one is clear (ventilator side). These are shown in Figure 11-88.

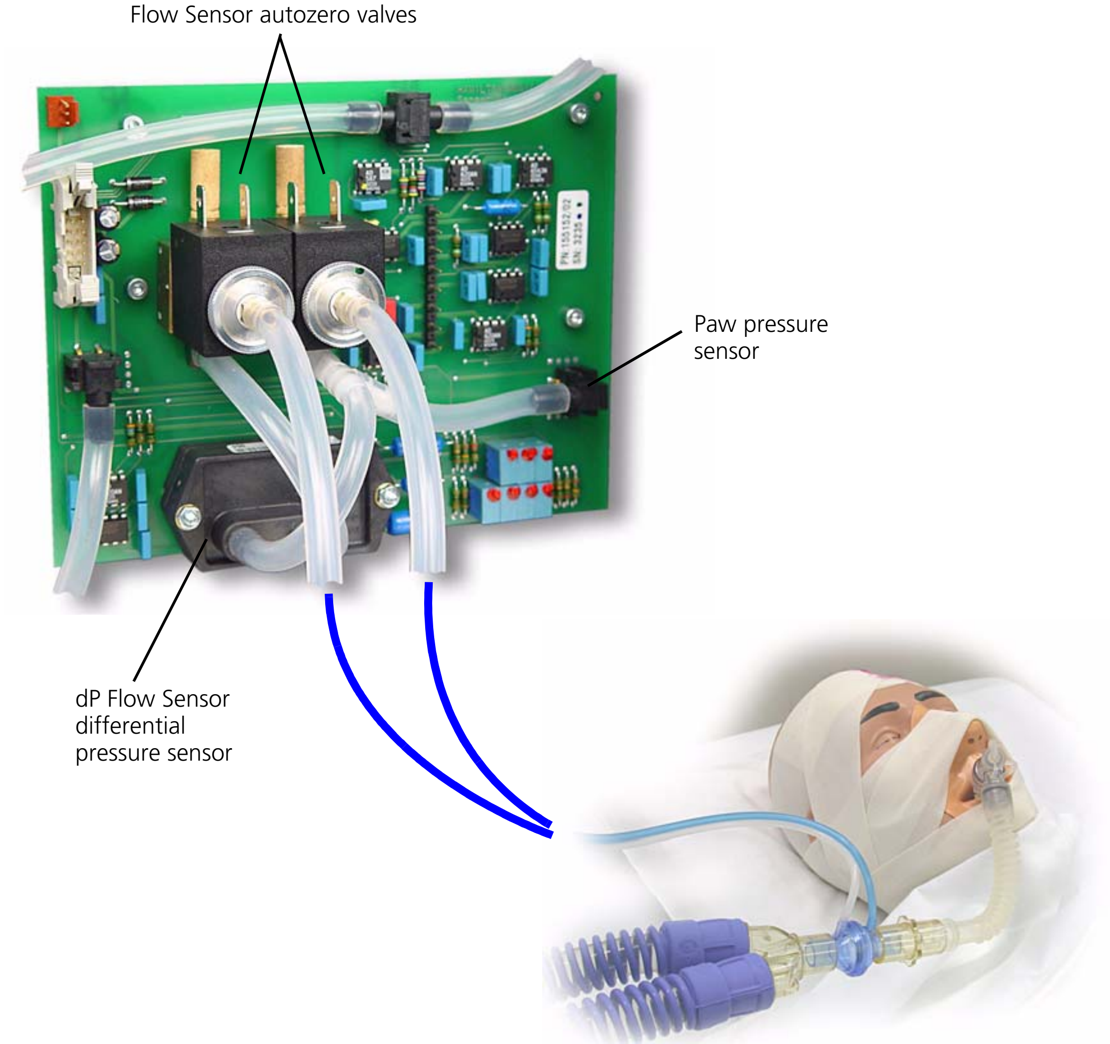


Figure 11-88. The Flow Sensor and pressure sensors on the sensor board

Inside GALILEO two measurements are made:

- Each tube is connected through the Flow Sensor autozero valves to one side of the *dP Flow Sensor differential pressure sensor*. (Figure 11-88.) This measures the difference in pressure between the two tubes. GALILEO calculates the gas flow from this measurement.
- The chamber nearest the patient (blue tube) also connects to the *Paw pressure sensor*. (Figure 11-88.) This measures the absolute pressure in the blue tube, and therefore the patient airway pressure.

Note

GALILEO does not require a flow of gas though the blue and clear pressure-sensing tubes to measure gas flow; it uses the pressure difference between the tubes. (There is a flow of gas through the tubes, but this is the *rinse flow*, as described in Section 11.15.5.2, *Rinse flow*.)

WARNING

The sensing tubes must always be positioned uppermost as shown in Figure 11-88 on page 11-80 so that fluid cannot drain into them. The tubes must not be kinked.

11.15.5 Further information

11.15.5.1 Accuracy

The Flow Sensors are very accurate (±5%) and suitable for all volume ranges of pediatric and adult applications.

11.15.5.2 Rinse flow

To stop the movement of condensation, bacteria and viruses from the Flow Sensor to the valves and sensors inside the ventilator, GALILEO supplies a continuous flow of gas from the tank, through the small blue (patient side) and clear (ventilator side) pressure-sampling tubes, to the Flow Sensor. This is called the rinse flow.

The rinse flow is created by the two flow restrictors shown in Figure 11-89 on page 11-82.

The flow restrictors take the form of connectors that screw directly into the tank. Inside each connector is a small, sintered disk "pill" that cannot be removed. You can see this in detail in Figure 11-90 on page 11-83.

With the introduction of the P/V Tool,

The rinse flow in GALILEO is therefore controlled mechanically, the rate of flow being determined by the characteristics of the "pill" in the flow restrictor, and by the pressure in the tank. The rinse flow restrictors in GALILEO produce a flow of approximately 25 ml/m, and have PN 155265. (GALILEO also uses a similar rinse flow restrictor for the auxiliary pressure measurement. For more information, see Section 2.8, *Components supporting auxiliary pressure measurement*, on page 2-22.)

11.15.5.3 Flow Sensor autozeroing

Background

The characteristics of all pressure sensors change in response to age and to environmental conditions such as temperature and humidity. For GALILEO to function optimally, it must compensate for these changes.

Two compensations are normally made for every pressure sensor:

- Zero offset.
  This is a compensation for the drift from specification of the electrical output from the pressure sensor while the pressure sensor is subjected to zero input. In the case of pressure sensors, zero input is considered to be ambient pressure.
- Gain offset.

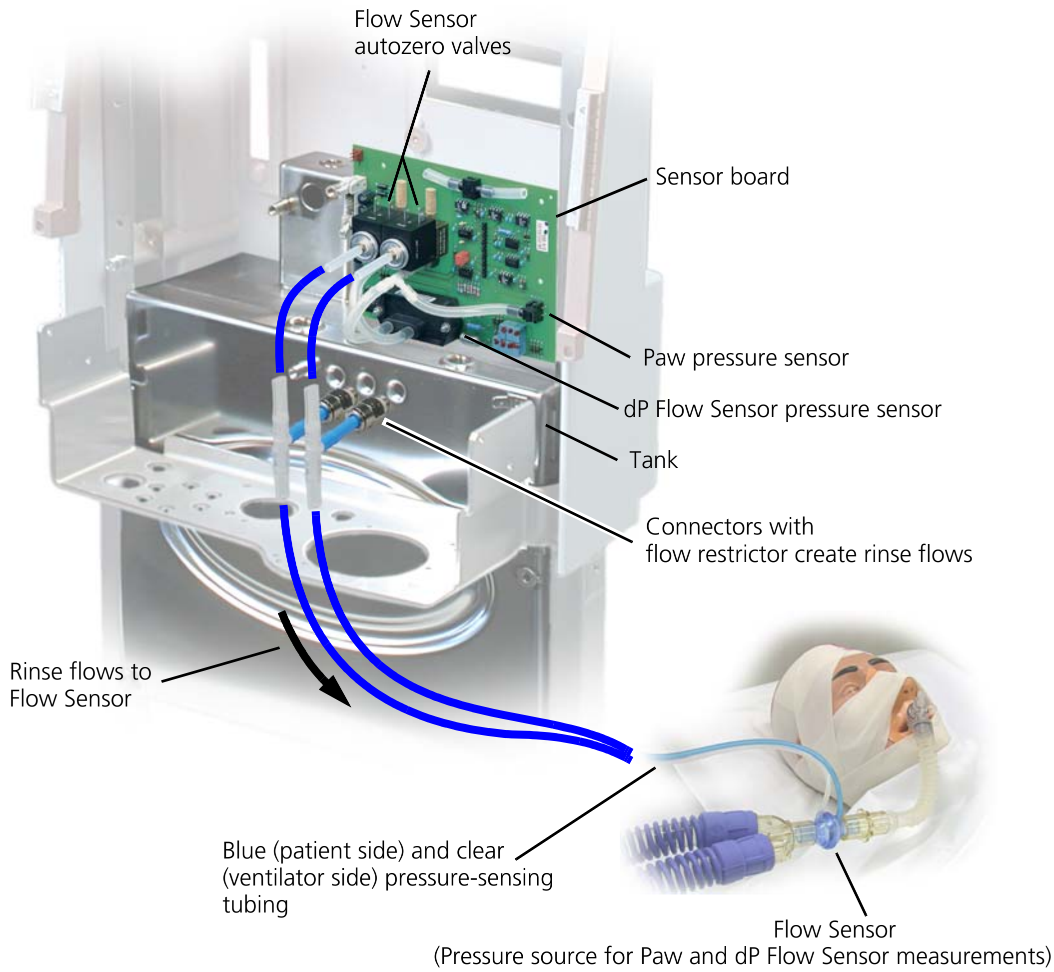


Figure 11-89. Details of the Flow Sensor connections to GALILEO

This is a compensation for the drift from specification of the electrical output from the pressure sensor while the pressure sensor is subjected to a known input above zero. This known input can vary, but is typically toward the upper working limits of the pressure sensor.

You adjust the zero and gain offsets of most pressure sensors when you run test software unit *8: Zero and full-scale calibration*, on page 10-34. However, for GALILEO to function optimally, it must repeatedly refresh the zero offset compensation that it applies to its most critical pressure sensors, the *dP Flow Sensor differential pressure sensor*, and the *Paw pressure sensor*. This process is referred to as Flow Sensor autozeroing.

GALILEO's Flow Sensor autozeroing procedure

During autozeroing, the flow sensor autozero valves (Figure 11-89 and Figure 11-88) open, to expose both sides of the *dP Flow Sensor differential pressure sensor*, and the single side of the *Paw pressure sensor* to ambient air pressure. While the valves are open, GALILEO measures the signal from the sensors, and notes the drift from their specified values. It later uses these known drifts as offsets when converting the electrical signal from the sensors to a pressure value.

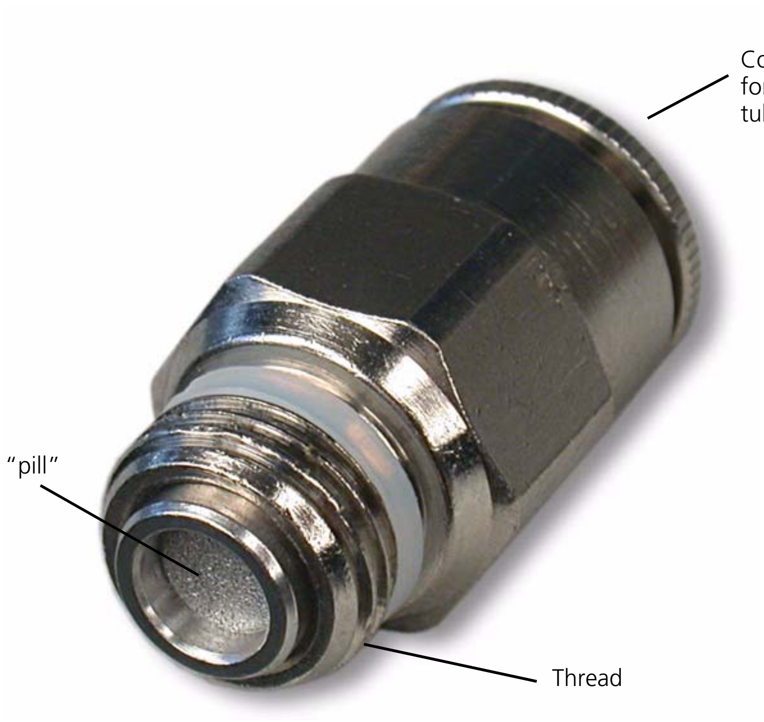


Figure 11-90. Details of a connector containing a "pill" flow restrictor

Note
Flow Sensor autozeroing does not affect the characteristics of the Flow Sensor, dP Flow Sensor differential pressure sensor, or the Paw pressure sensor. Instead, it provides offset values that GALILEO later uses to interpret dP Flow Sensor signals during normal ventilation.

During an autozero procedure, which lasts only a fraction of a second, the patient is ventilated normally. However, since parameters such as expired tidal volume, resistance, compliance, and PEEP cannot be measured or monitored online during this time, GALILEO uses the most recently measured values until the procedure is complete.

GALILEO performs the autozeroing according to the following schedule:

Autozezro procedure and zero offset calculation	Time
1st procedure	2 minutes after switching on
2nd procedure	5 minutes after switching on
3rd procedure	8 minutes after switching on
4th procedure	11 minutes after switching on
5th procedure	14 minutes after switching on
6th procedure	17 minutes after switching on
7th procedure	20 minutes after switching on
nth procedure...	20 minutes later...

Table 11-12. dP Flow Sensor autozero schedule

11.16 Front panel keys

CAUTION

Do not attempt to repair the front panel keys. HAMILTON MEDICAL AG does not permit anyone to make any repairs in the field at a level lower than the smallest parts provided in Appendix H, *Spare parts*.

11.16.1 References

- Position in enclosure: Section 3.2, *Components in the front enclosure*, on page 3-2.
- Testing:
  - TSW 2.4, *Performing the LED, LCD, and relay checks*, on page 9-8.

  Or:
  - Unit 2.4, *Performing the LED, LCD, and relay checks*, on page 10-11.
- Part number: PN 155260, shown in Appendix H.16, *Stickers*, on page H-16.

11.16.2 Placement

The front panel keys are attached to GALILEO's front panel by adhesive. Their position is shown in Figure 11-91 below, and in Figure 3-1, *Components in the front enclosure*, on page 3-2.

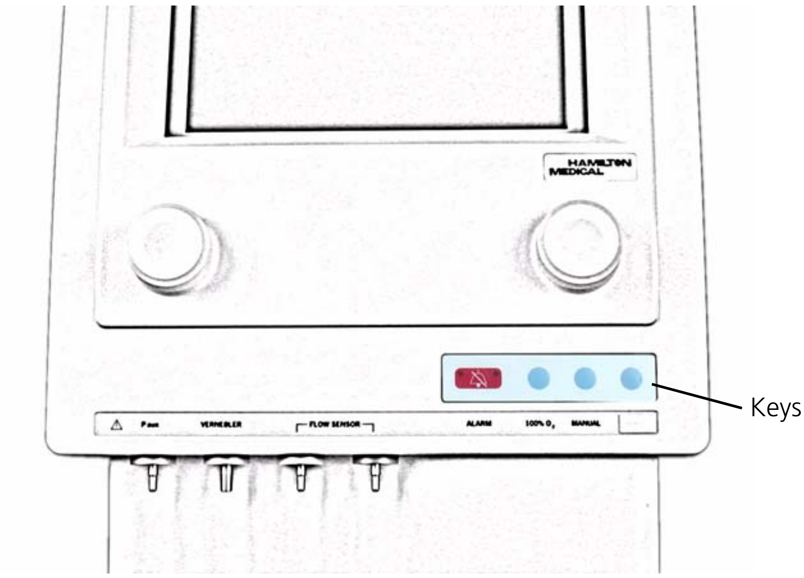


Figure 11-91. The position of the front panel keys (pre-November 2004 type)

11.16.3 Purpose

The purpose of the front panel keys is to enable medical users and engineers to interact with GALILEO.

For more information about medical use, see the appropriate GALILEO operators' manual.

For more information about use by engineers, see Section 9.5, *Entering test software mode*, on page 9-2, or Section 10.5, *Entering test software mode*, on page 10-2.

11.16.4 Description and function

There are two types of front panel keys: the original, and the new-look keys, introduced in November 2004, as part of the new-look GALILEO. The functional properties of the two kinds of keys are identical.

Figure 11-92 shows the old design.

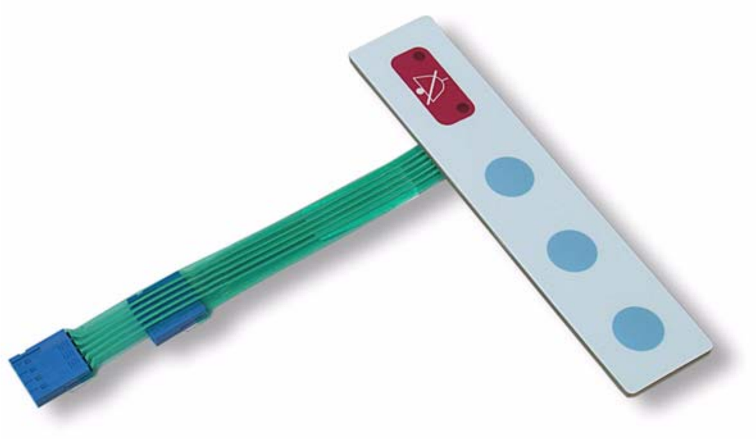


Figure 11-92. The front panel keys (old type)

Figure 11-92 shows the new look keys, introduced in November 2004.

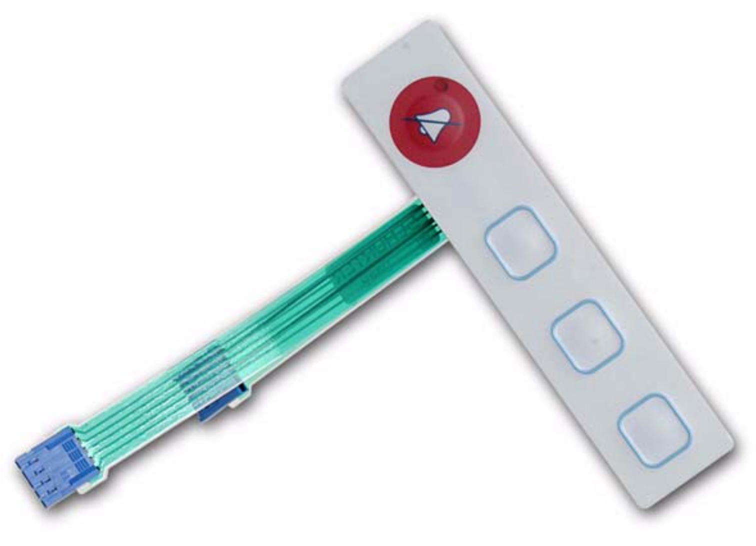


Figure 11-93. The front panel keys (new type)

The keys comprise a thin plastic strip of a sandwich construction. There are four keys (or buttons) and two LEDs.

The back of the panel is self-adhesive, and has two non-detachable ribbon cables.

It is not possible to open or repair the keys.

11.16.5 Replacing the front panel keys

Removing the old keys

1. Open GALILEO's main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
2. Remove from the connector board the two ribbon cable connectors belonging to the keys.

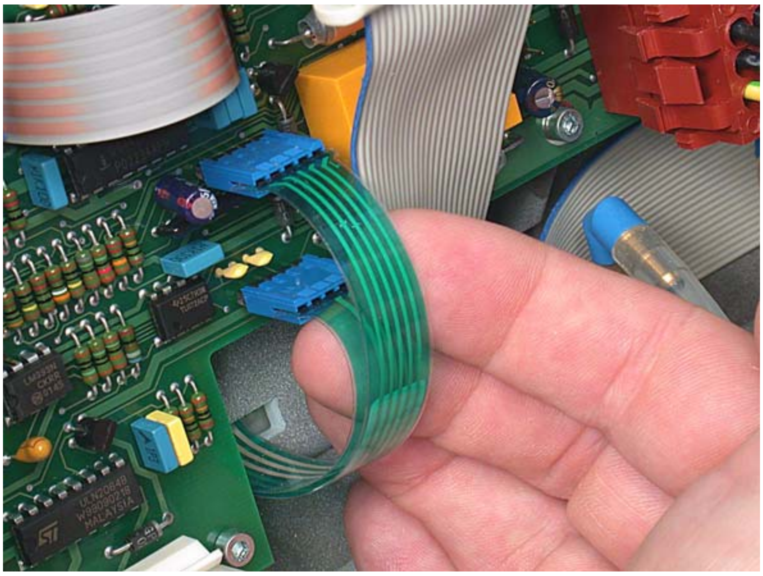


Figure 11-94. The two ribbon cable connectors on the connector board

3. Push the keys off the front panel using a hexagonal-drive (Allen) key. (Figure 11-95 and Figure 11-96.)

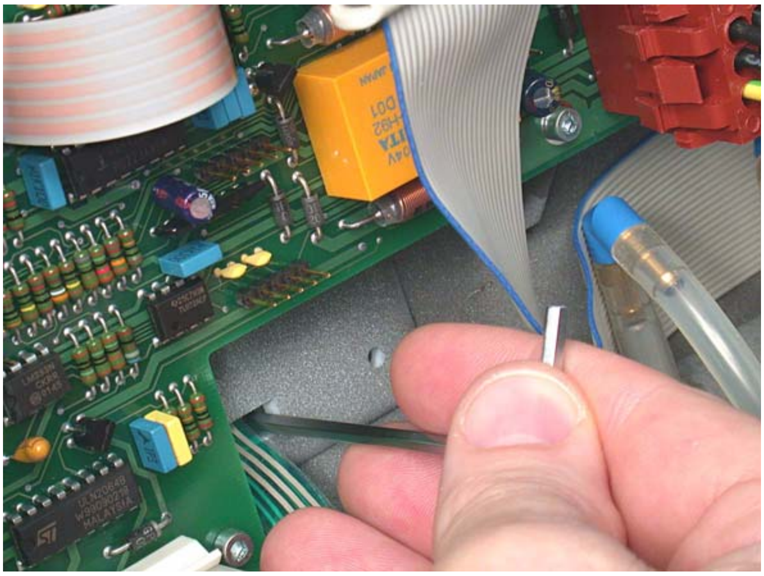


Figure 11-95. Pushing the keys off the front panel (1)

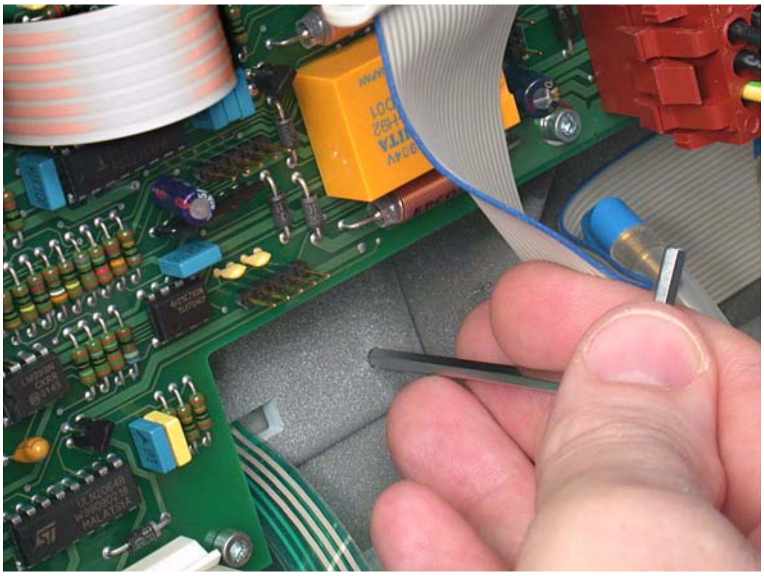


Figure 11-96. Pushing the keys off the front panel (2)

Note
It is possible to rub off any remaining old adhesive from the front panel, without using any solvent.

Fitting the new keys

To fit the new front panel keys:

1. Remove from the keys the paper covering the adhesive.
2. Push the keys into place.
3. Connect the ribbon cables to the connector board.
4. Close GALILEO.

Testing

WARNING

You must perform all the following tests.

After fitting new front panel keys, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
  - Section 9, *Running Original or Upgrade 1 test software*
  - Section 10, *Running Upgrade 2 test software*

11.17 Gas inlet assemblies

CAUTION

You can replace parts on the gas inlet assemblies. However, HAMILTON MEDICAL AG does not permit anyone to make any repairs in the field at a level lower than the smallest parts provided in Appendix H, *Spare parts*.

11.17.1 References

- Position in enclosure: Section 2.2, *Components managing the principle gas flow*, on page 2-2.
- Testing: There is no special test for the gas inlet assemblies.
- Maintenance:
  - Section 5, *Hospital preventive maintenance*.
  - Section 6, *Engineer preventive maintenance*.
- Part number: PN 279676, shown in Appendix H.19, *Miscellaneous*, on page H-24.

11.17.2 Placement

Each gas inlet assembly comprises:

- Connector to an external gas source.
- Gas filter.
- Water trap bowl.
- Water release/pressure check valve.

The two gas inlet assemblies are mounted on the mixer block, at the rear of GALILEO, as shown in Figure 11-97 and Figure 11-98.

Note

The purpose and function of the two kinds of mixer block are identical. However, construction is different: the new-model mixer block is an integrated, single unit.

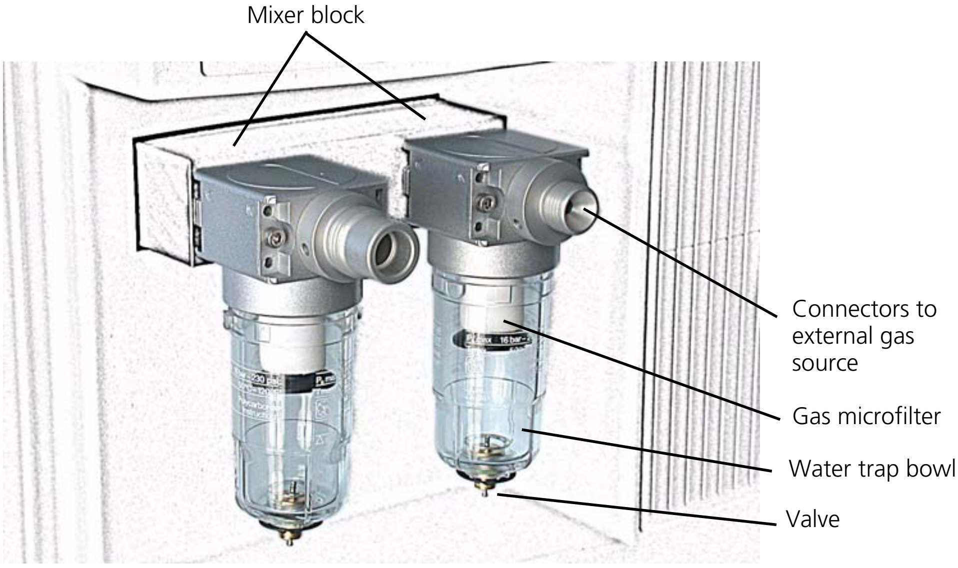


Figure 11-97. The position of the air and oxygen gas inlet assemblies on mixer block PN 155333

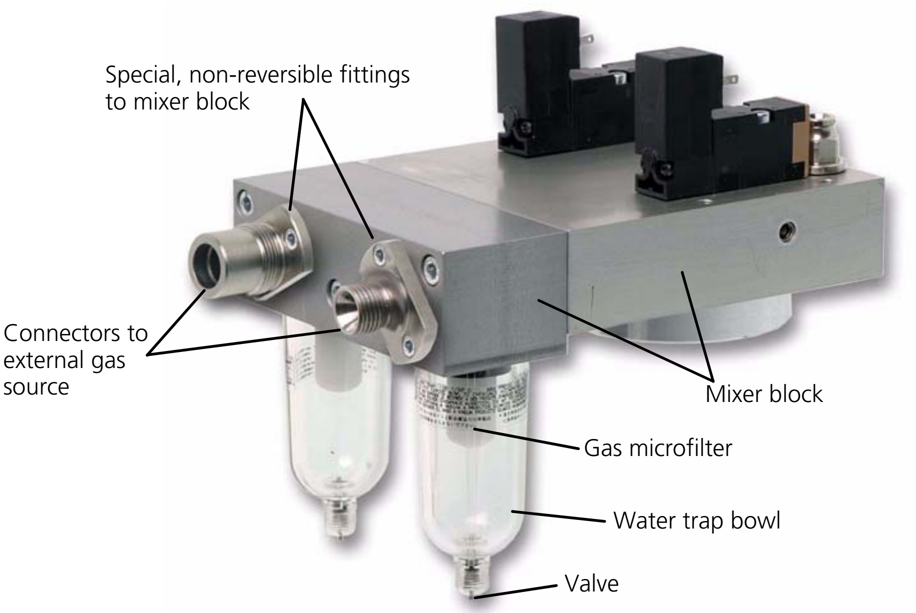


Figure 11-98. The position of the air and oxygen gas inlets on mixer block PN 155587

11.17.3 Purposes

Each inlet assembly (as shown in detail on Figure 11-19) serves several purposes:

- The ***connector*** provides a gas-tight, standardized connection to an external source of air or oxygen.
- The ***gas filter*** removes dirt particles in the oxygen or air from the external source, and therefore provides clean gas for GALILEO. The size of the filter is 5 µm.
- The ***water trap bowl*** acts as a reservoir for any water that condenses as it passes through the gas inlet. It therefore ensures that only dry oxygen or air enters GALILEO.
- The ***water release/pressure check valve*** serves two purposes: it enables users to empty water traps that are filled with water, or enables users to check the connection of the gas supply, if there is no water in the water trap.

11.17.4 Description and function

Connectors

The gas assemblies require either DISS or NIST gas connectors, depending on the country in which GALILEO is installed, as shown in Figure 11-99 and Figure 11-100 (new NIST connectors not available at time of printing). In addition, a few countries, such as France, have their own national systems.

Figure 11-99. Air and oxygen DISS and NIST connectors for old-model mixer block PN 155333

Figure 11-100. **PN 155701, DISS air and oxygen connectors for new-model mixer block PN 155587**

GALILEO is normally delivered with DISS connectors, but can be adapted to NIST by using NIST kit PN 155330 for old-model mixer block PN 155333, or by using NIST kit PN 155702 for new mixer block PN 155587. (For a complete comparative list of part numbers, see Table 11-13, *List of replaceable parts*, on page 11-143.)

With the old-model mixer block, the threads in the block for the NIST or DISS connectors are identical (Figure 11-99). With the new-model mixer block, the fittings to the block are different, to make connection mistakes almost impossible (Figure 11-100).

In all cases, the threads on the connectors to the external gas supplies are different from one another. This ensures that only the external oxygen supply can be connected to the oxygen inlet assembly, and only external air to the air assembly.

Oxygen and air must enter the assemblies at a pressure of 2 to 6 bar (29 to 87 PSI).

Water traps, filters and valves

The construction of gas inlet assembly PN 279677, for the old-model mixer block PN 155333, is shown in Figure 11-101. The principles of operation are identical for the new gas inlets that are integrated into new-model mixer block PN 155587.

The flow of gas through the inlet assemblies is as follows:

- Firstly, oxygen or air from an external source (compressor, cylinder or piped supply) enters at the rear of the metal housing.
- The gas flows into the center of the filter, and is forced out through the filter. During this process, any condensed water can drip into the clear plastic casing that forms the filter housing.
- Finally, gas flows back up into the metal housing, and into GALILEO.

You can use the valve at the bottom of the water trap bowl to release water (but be careful of overflows!) or you can use it to make sure that gas pressure is present, if no water is condensed. (Press it to hear the gas escaping.)

Depending upon the installation, water can condense and collect in the water trap bowl. If this happens, it must be regularly released before it covers the high water mark printed on the filter housing. Providing that there is no high pressure hose connected, the easiest way of emptying the water trap bowl is by unscrewing the filter housing, not by pushing the water release/pressure check valve. Releasing water is normally performed by hospital staff.

Figure 11-101. Details of gas inlet assembly PN 279677

11.17.5 Further information

For a list of part numbers for the old-model and new-model mixer blocks, see Table 11-13, *List of replaceable parts*, on page 11-143.

11.17.6 Maintenance

WARNING

- **Always make sure that oxygen and air inlet connectors are correctly fitted. (See Figure 11-99, *Air and oxygen DISS and NIST connectors for old-model mixer block PN 155333*, on page 11-91, and Figure 11-103, *Air and oxygen connectors (DISS)*, on page 11-95.)**
- **You must inform hospital staff that they must empty the water trap bowls as required, because water passing into GALILEO can cause the unit to fail.**

Note

Make sure that the gas filters are regularly replaced by hospital staff, as indicated in Section 6, *Engineer preventive maintenance*. If the filter is not clean, replace it yourself and remind hospital staff of the need to perform this task regularly.

11.17.7 Replacing the gas inlet assembly on old-model mixer block PN 155333

If a gas inlet assembly on old-model mixer block PN 155333 must be renewed, simply unscrew it from the mixer block as shown in Figure 11-102, and replace it with a new one.

CAUTION

Do not touch the one-way valve that is mounted in the mixer block immediately under each gas inlet assembly (Figure 11-102). These valves seldom misfunction. However, if disturbed they often break, and must be replaced.

Figure 11-102. Removing the gas inlet assemblies

The inlet assemblies are identical apart from their NIST and DISS connectors, so be careful to place them correctly. Figure 11-103 shows the correct mounting of assemblies with DISS connectors.

Figure 11-99, *Air and oxygen DISS and NIST connectors for old-model mixer block PN 155333*, on page 11-91 shows details of all connectors.

Figure 11-103. Air and oxygen connectors (DISS)

Note
It is not necessary to perform the test software tests after replacing a gas inlet assembly.

11.17.8 Replacing the gas inlet assembly on new-model mixer block PN 155587

If a gas inlet assembly on new-model mixer block PN 155587 must be renewed, open the mixer block by removing the hexagonal (Allen) bolts indicated in Figure 11-104. It is not necessary to remove the mixer block from GALILEO to do this.

Figure 11-104. The three screws securing the new-model mixer block

A one-way valve is mounted in the air passage, and another in the oxygen passage, in the main part of the mixer block.

Note
It is not necessary to perform the test software tests after replacing a gas inlet assembly.

11.18 GCP EPROM

11.18.1 References

- Position in enclosure: Section 3.2, *Components in the front enclosure*, on page 3-2.
- Compatibility: Appendix C, *GMP software/hardware compatibility*.
- Testing:
  - *TSW 1: GMP Selftest*, on page 9-3.
  - *TSW 5: GCP-GMP Communication*, on page 9-19.

  Or:
  - *1: Microprocessor checks*, on page 10-4.
  - *5: GCP–GMP communication checks*, on page 10-23
- Part numbers: Appendix D, *Software revisions, features and compatibility*.

11.18.2 Placement

The *GCP* EPROM is positioned in the front enclosure, on the *control board*. This is shown in Figure 11-105 below, and in Figure 3-1, *Components in the front enclosure*, on page 3-2.

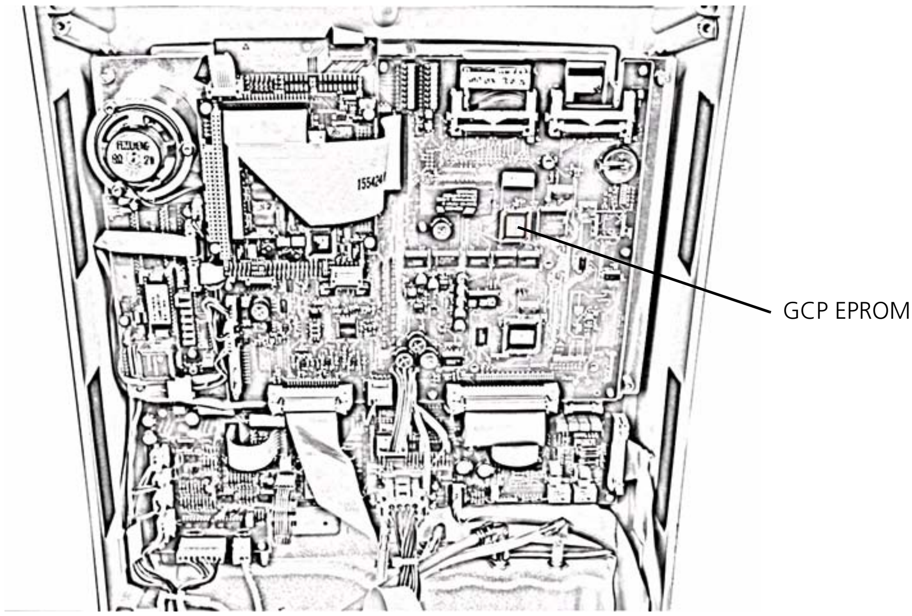


Figure 11-105. Position of the GCP EPROM in the front enclosure

11.18.3 Purpose

The purpose of the GALILEO control processor (GCP) EPROM is to calculate values to control the valves that, in turn, control the pneumatic circuits. The microprocessor contains its own software.

11.18.4 Description and function

See Section 11.18.3, *Purpose*.

11.18.5 Replacing the GCP EPROM

If replacing the GCP EPROM when updating or upgrading to new software, it is very likely that you must also replace the GPT controller and GMP CompactFlash program carrier; the instructions accompanying your update or upgrade kit will supply this information.

To replace the GCP EPROM alone:

1. Open GALILEO's main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
2. Locate the GCP EPROM. (Section 11.18.2, on page 11-97.)
3. Remove the GCP EPROM with an integrated-circuit extractor (Figure 11-106). For more information about this tool, see Appendix A.3.1, *IC extractor tool*, on page A-1.

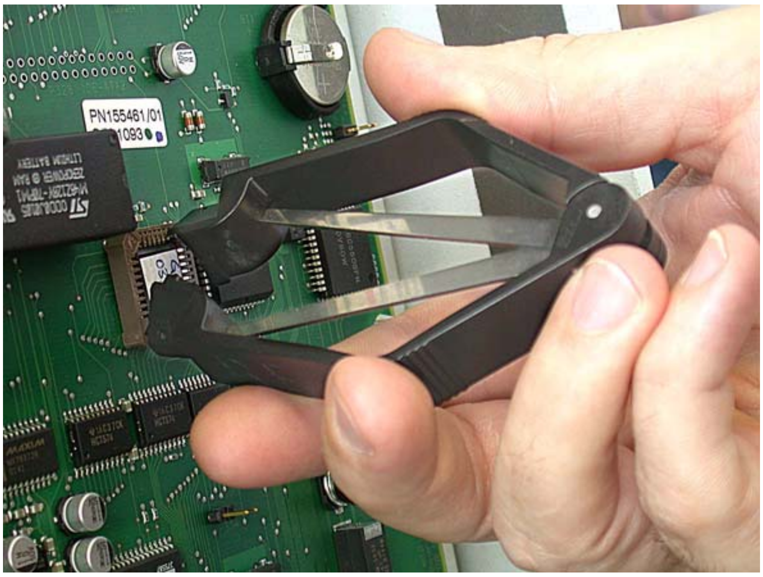


Figure 11-106. Removing the GCP

4. Insert the new GCP EPROM by pushing it into place. (Figure 11-107.)

CAUTION

Make sure you align the flat on the corner of the GCP EPROM with the flat in the corner of the carrier.

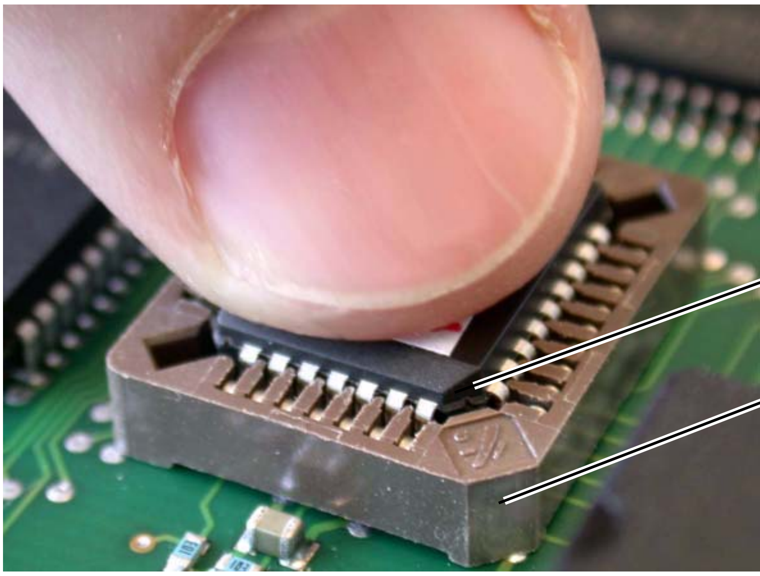


Figure 11-107. Pushing the new GCP EPROM into place

Testing

WARNING

You must perform all the following tests.

After fitting a new GCP EPROM, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
  - Section 9, *Running Original or Upgrade 1 test software*
  - Section 10, *Running Upgrade 2 test software*

11.19 GMP CompactFlash program carrier

11.19.1 References

- Position in enclosure: Section 3.2, *Components in the front enclosure*, on page 3-2.
- Testing: There is no special test for the program carrier.
- Further information: Appendix C, *GMP software/hardware compatibility*, on page C-1.
- Part numbers: Appendix D, *Software revisions, features and compatibility*.

11.19.2 Placement

The GMP CompactFlash program carrier is located in the front enclosure, on the *control board*. This is shown in Figure 11-108 below, and also in Figure 3-1, *Components in the front enclosure*, on page 3-2.

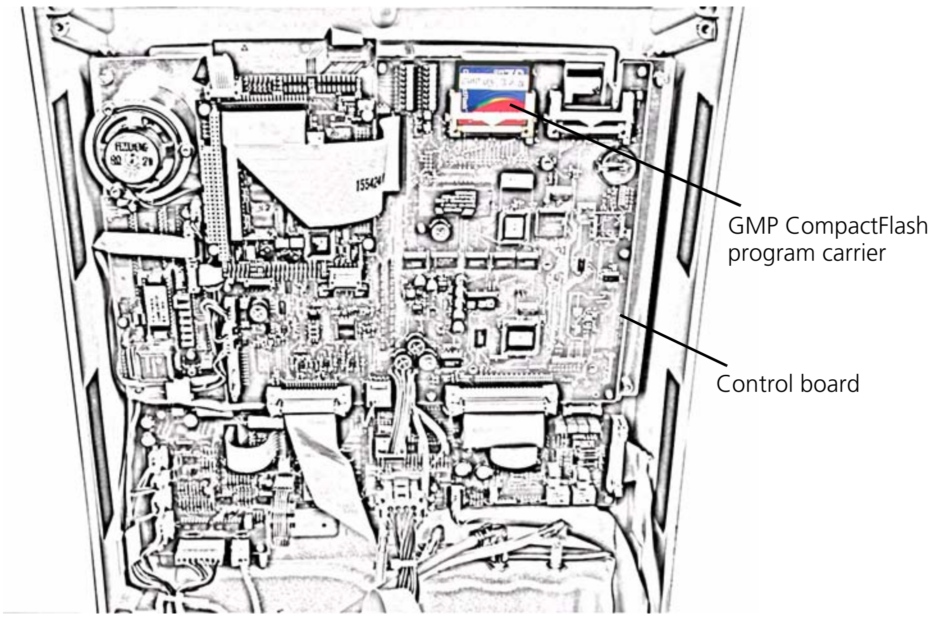


Figure 11-108. Position of the GMP CompactFlash program carrier in the front enclosure

11.19.3 Purpose

The purpose of the GALILEO main processor (GMP) CompactFlash program carrier is to hold the software required by the *GMP*.

11.19.4 Description and function

See Section 11.19.3, *Purpose*.

11.19.5 Replacing the GMP CompactFlash

If replacing the GMP CompactFlash when updating or upgrading to new software, it is very likely that you must also replace the GPT controller and GCP EPROM as well; the instructions accompanying your update or upgrade kit will supply this information.

To replace the GMP CompactFlash alone:

1. Open GALILEO's main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
2. Locate the GMP CompactFlash. (Section 11.19.2, on page 11-100.)
3. Remove and replace the CompactFlash as required.

CAUTION

The CompactFlash containing the GMP software must always be positioned in the left-hand slot. The right-hand slot is for the optional CompactFlash used for downloading the *event log*.

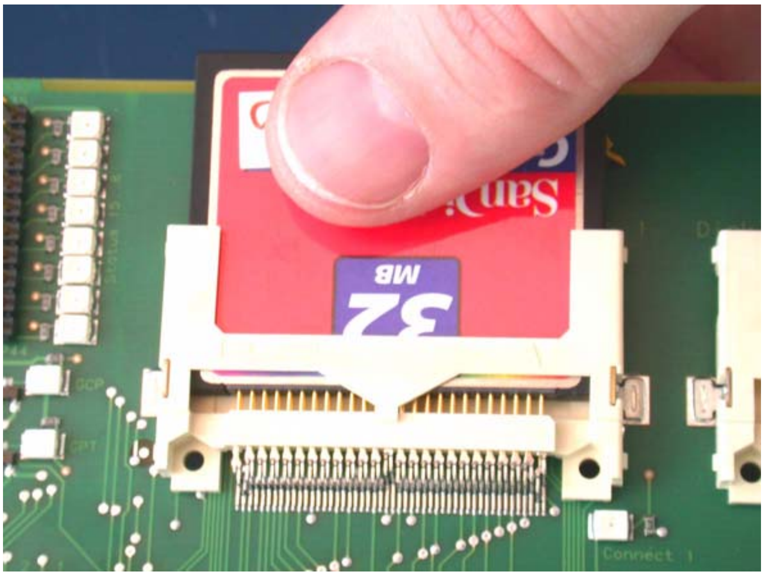


Figure 11-109. Removing or fitting the GMP software CompactFlash

Testing

WARNING

You must perform all the following tests.

After fitting a new GMP CompactFlash, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
    - Section 9, *Running Original or Upgrade 1 test software*
    - Section 10, *Running Upgrade 2 test software*

11.20 GPT controller

11.20.1 References

- Position in enclosure: Section 3.2, *Components in the front enclosure*, on page 3-2.
- Testing:
  - *TSW 1: GMP Selftest*, on page 9-3.
  - *TSW 2: GPT-GMP Communication*, on page 9-6.

  Or:
  - *1: Microprocessor checks*, on page 10-4.
  - *2: GPT–GMP communication & LED checks*, on page 10-8.
- Part number: Appendix D, *Software revisions, features and compatibility*.

11.20.2 Placement

The GPT controller is positioned in the front enclosure, on the control board. This is shown in Figure 11-110 below, and also in Figure 3-1, *Components in the front enclosure*, on page 3-2.

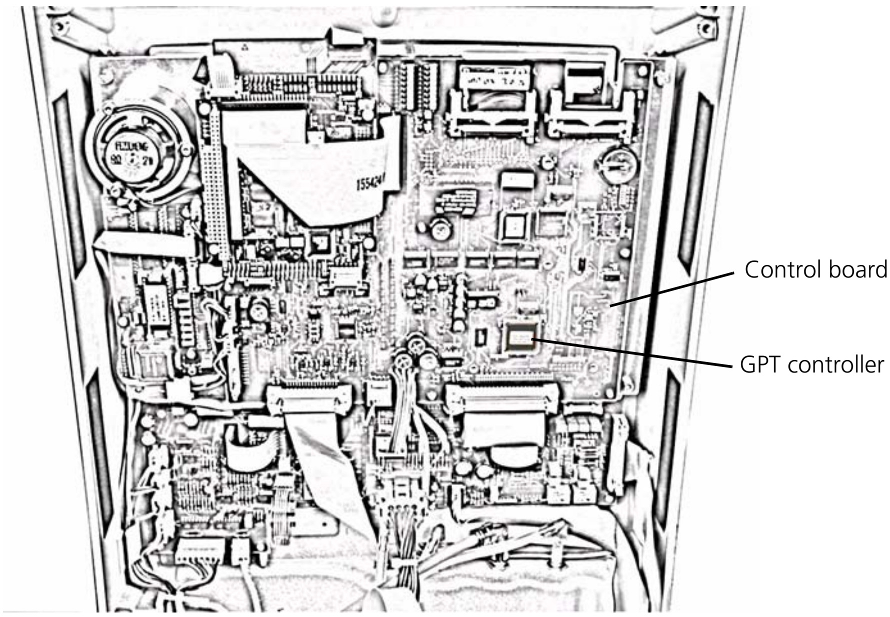


Figure 11-110. Position of the GPT in the front enclosure

11.20.3 Purpose

The purpose of the GALILEO press-and-turn controller (*GPT*) is to manage the press-&-turn knobs, and the four keys on the front panel.

11.20.4 Description and function

The GPT is classed as a controller: this is a microprocessor with its own on-chip RAM and ROM.

11.20.5 Replacing the GPT controller

If replacing the GPT when updating or upgrading to new software, it is very likely that you must also replace the GCP and GMP CompactFlash program carrier; the instructions accompanying your update or upgrade kit will supply this information.

To replace the GPT alone, follow the instructions in Section 11.18.5, *Replacing the GCP EPROM*, on page 11-98, substituting the GPT for the GCP.

Testing

WARNING

You must perform all the following tests.

After fitting a new GPT, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
  - Section 9, *Running Original or Upgrade 1 test software*
  - Section 10, *Running Upgrade 2 test software*

11.21 Indicator board / battery panel

CAUTION

Do not attempt to repair the indicator board / battery panel. HAMILTON MEDICAL AG does not permit anyone to make any repairs in the field at a level lower than the smallest parts provided in Appendix H, *Spare parts*.

11.21.1 References

- Position in enclosure: Section 3.4, *Components in the column*, on page 3-12.
- Testing: See the appropriate GALILEO operator's manual.
- Part number: PN 155354, shown in Appendix H.7, *Boards*, on page H-5.

11.21.2 Placement

Indicator board

The indicator board is positioned inside the column, where it is screwed to the front of the column. It is shown in Figure 11-111 below, and also in Figure 3-3, *Components in the column*, on page 3-12.

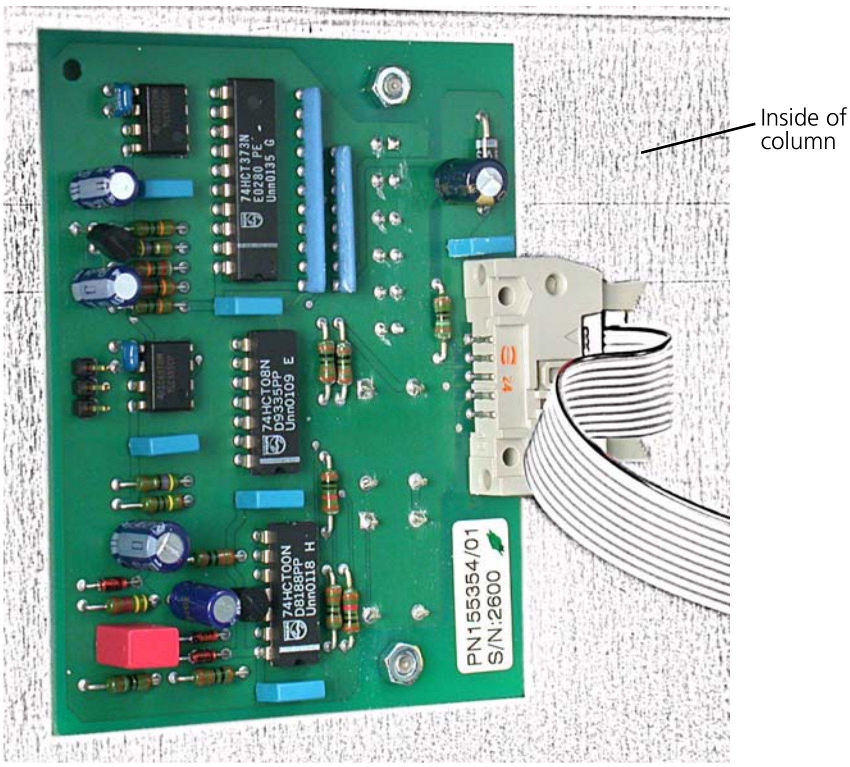


Figure 11-111. **Position of the indicator board inside the column**

Battery panel

The battery panel is positioned with adhesive on the front of the column, directly on top of the LEDs and switches on the underlying indicator board. It is shown in Figure 11-112 below, and also in Figure 3-3, *Components in the column*, on page 3-12.

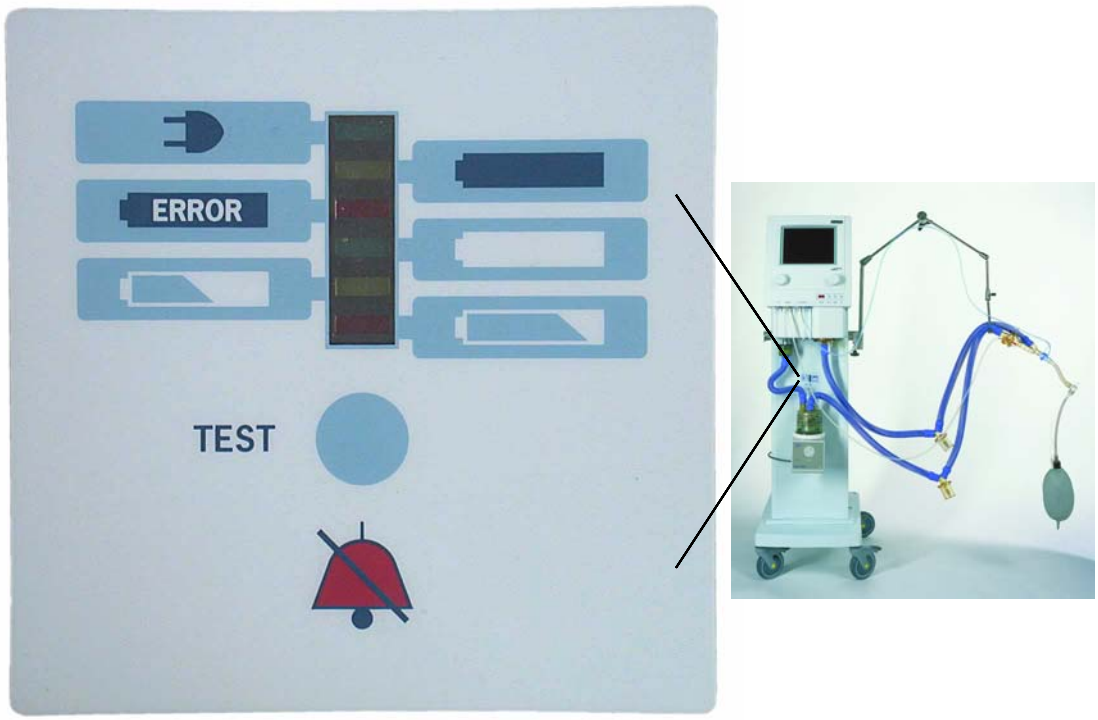


Figure 11-112. **Position of the battery panel on the column**

11.21.3 Purpose

Indicator board

The purpose of the indicator board is to provide the switches and LEDs for the battery panel.

Battery panel

The purpose of the battery panel is to enable the user to test and manage the backup batteries.

11.21.4 Description and function

See Section 11.21.3, *Purpose* above.

11.21.5 Replacing the indicator board and battery panel

Indicator board

To replace the indicator board:

1. Open the column, as described in Section 11.5, *Opening the column*, on page 11-6.

> **Note**
> It is not necessary to remove the cover on the column, only to loosen it.

2. Remove the ribbon cable from the indicator board, and unbolt it from the column.

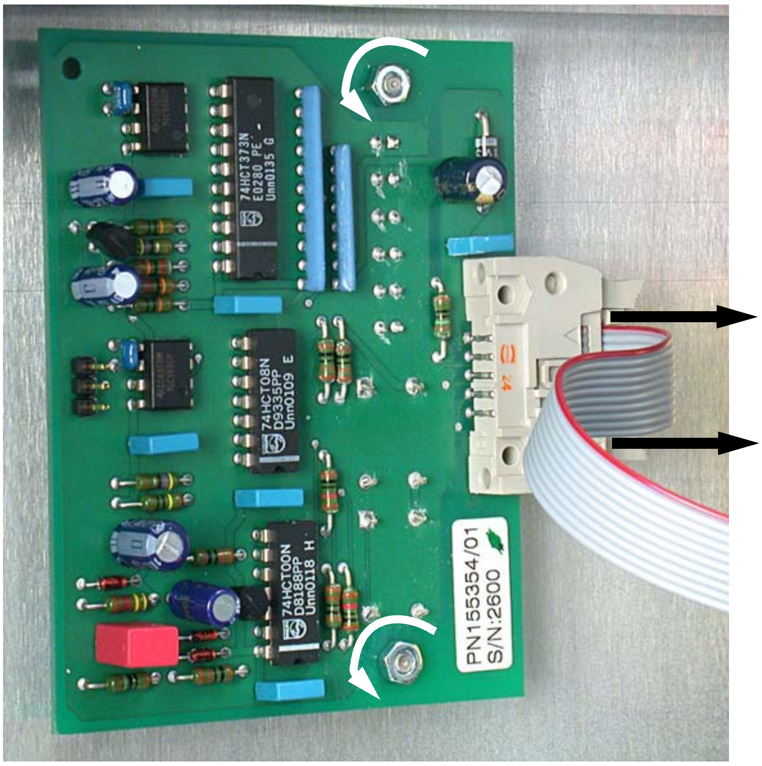


Figure 11-113. Removing the indicator board

To fit a new indicator board, simply reverse the removal procedure.

Battery panel

To remove the battery panel, peel it off. You might find that some glue stays on the column. You can rub this off without using a solvent.

To fit the new battery panel, remove the backing paper, and position it carefully over the knobs and LEDs of the underlying indicator board.

Testing

WARNING

You must perform all the following tests.

After fitting a new indicator board, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
  - Section 9, *Running Original or Upgrade 1 test software*
  - Section 10, *Running Upgrade 2 test software*

Note

It is not necessary to perform the test software after replacing only the sticker.

11.22 Inspiratory (servo) valve and servo board

CAUTION

Do not attempt to repair the inspiratory valve or servo board. HAMILTON MEDICAL AG does not permit anyone to make any repairs in the field at a level lower than the smallest parts provided in Appendix H, *Spare parts*.

11.22.1 References

- Position in enclosure:
  - Section 2.2, *Components managing the principle gas flow*, on page 2-2.
  - Section 2.3, *Components performing principle pressure and flow measurements*, on page 2-6.
- Testing:
  - *TSW 8: Zero and Fullscale*, on page 9-28
  - *TSW 14: Servo and Flow Sensor*, on page 9-63.

  Or:
  - *8: Zero and full-scale calibration*, on page 10-34
  - *14: Inspiration valve check*, on page 10-75.
- Part number: PN 155496, shown in Appendix H.10, *Valves and assembly groups*, on page H-8.

11.22.2 Placement

The inspiratory valve (also known as the servo valve), together with the servo board, is mounted on the tank as shown in Figure 11-114 below, and in Figure 2-1, *Components managing the principle gas flow*, on page 2-2. (The tank is a part of GALILEO's chassis.)

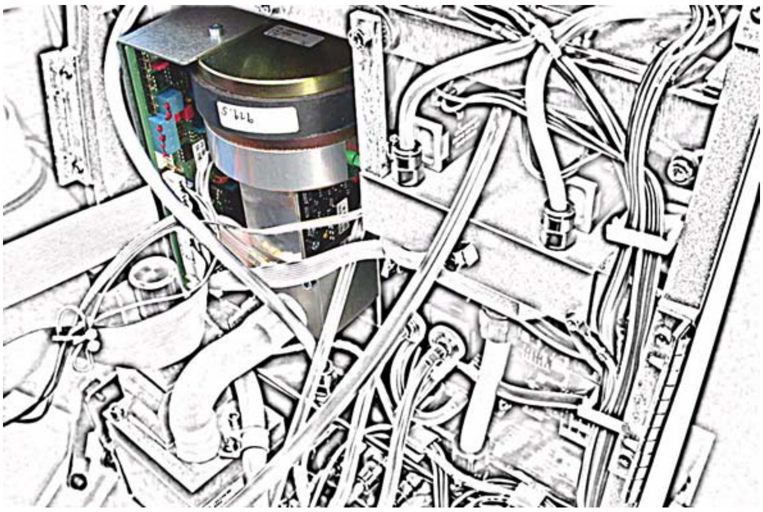


Figure 11-114. The position of the inspiratory valve

11.22.3 Purpose

Inspiratory (servo) valve

The purpose of the inspiratory valve is to deliver the air and oxygen mixed in the tank to the breathing circuit at the volumes and pressures required by GALILEO. GALILEO's requirements are determined by the respiration mode, the settings selected by the user, and by the responses of the patient.

For information about gas flow through the inspiratory valve in the context of the complete pneumatic system, see Section 2.2, *Components managing the principle gas flow*, on page 2-2.

Servo board

The purpose of the servo board is principally to hold the pressure sensors, potentiometers, and servo circuits that manage the inspiratory valve.

11.22.4 Description and function

Inspiratory (servo) valve

The inspiratory valve is a sophisticated, electronically-operated valve, capable of being controlled very precisely.

The main parts of the valve are:

- Magnet
- Positioning coil
- Plunger
- Position sensing device (PSD)

The positioning coil moves the plunger up and down. The sensor measures the position of the plunger and therefore the opening of the triangular orifice through which the gases flow.

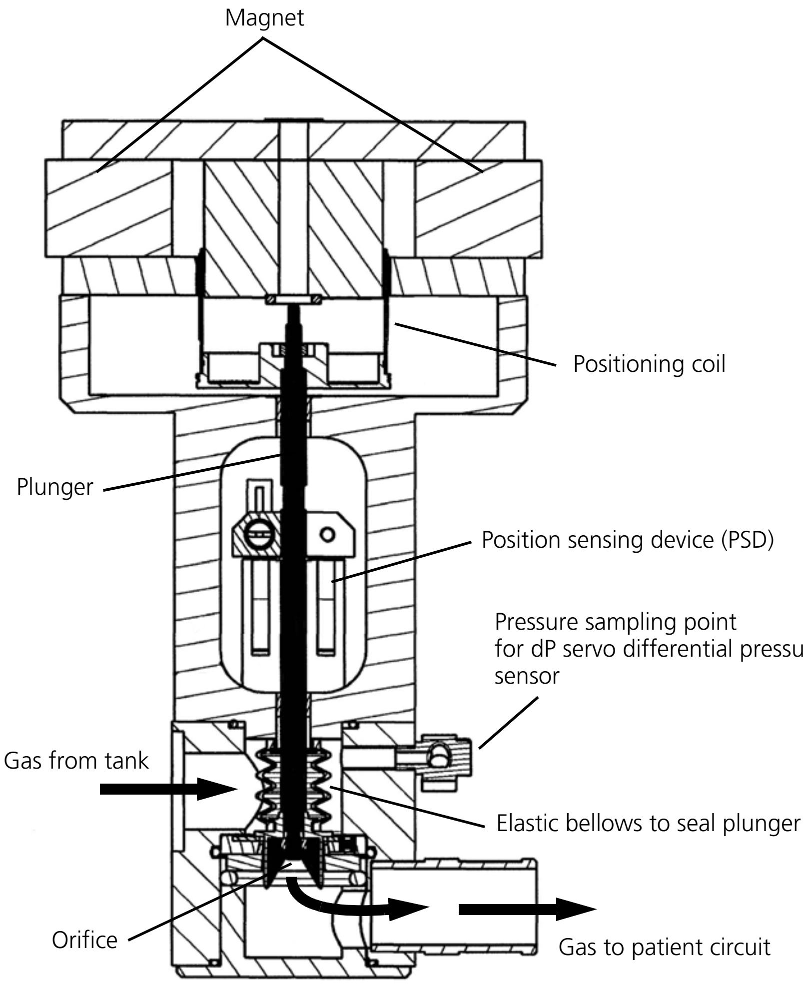


Figure 11-115. Inspiratory valve PN 155496

In addition to the parts shown above, two other components are vital for the functioning of the inspiratory valve:

- The *dP servo differential pressure sensor*.
- The *Ppat pressure sensor*.

These are both positioned on the *servo board*.

The *dP servo differential pressure sensor* measures the pressure difference across the triangular orifice of the inspiratory valve. GALILEO uses this measurement, together with the known flow restriction caused by the size of the triangular orifice (this information supplied by the position sensor) to calculate the flow of gas through the valve.

The *Ppat pressure sensor* measures pressure at the outlet of the inspiratory valve.

The inspiratory valve is therefore able to deliver gas in the volume (using the *dP servo differential pressure sensor) or at the pressure (using Ppat pressure sensor) required by GALILEO's respiration mode and user settings.*

Servo board

The servo board holds the:

- *dP servo differential pressure sensor*.
- *Ppat pressure sensor*.
- The amplifiers and filters for the pressure sensors.
- The potentiometers that enable you to calibrate these pressure sensors.
- The inspiratory valve control circuits.

You adjust the pressure sensors in Test 8, *Zero and Fullscale*, on page 9-28 or Test 8, *Zero and full-scale calibration*, on page 10-34.

The fan plugs into the servo board in original and Upgrade 1 GALILEOs.

11.22.5 Further information

Over the production lifetime of GALILEO, there have been many refinements and several major changes made to the inspiratory valve.

Note
The inspiratory valve is only available together with the servo board, in module PN 155496.

WARNING
Never apply lubricant to the inspiratory valve or to any other part of GALILEO.

11.22.6 Replacing the inspiratory valve / servo board assembly

You cannot replace the inspiratory valve or the servo board individually. You must replace the complete module containing both components. (PN 155496.)

Removing the old valve and servo board

1. Remove the two screws securing the safety valve block. The screws are located on the outside of the chassis, near to the to-patient port.

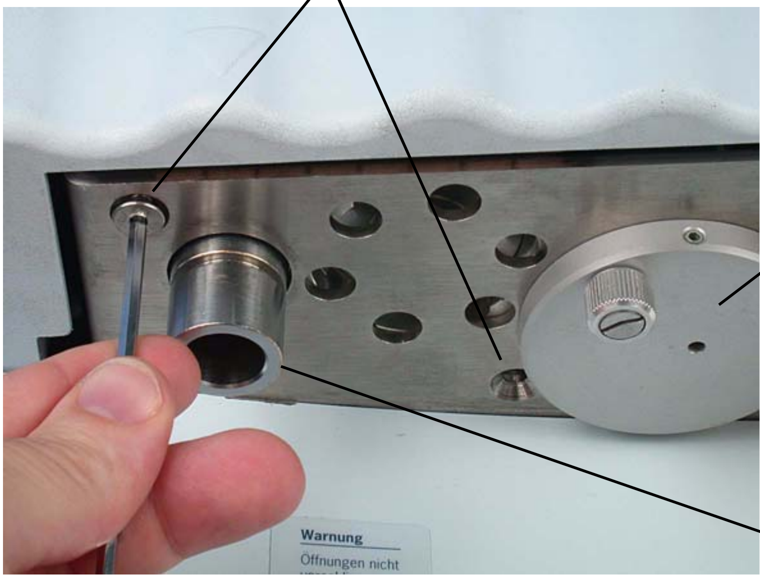


Figure 11-116. Unscrewing the safety valve block

2. Open GALILEO's main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
3. Locate the inspiratory valve / servo board assembly. (Section 11.22.2, on page 11-108.)
4. Pull the white, shaped tube off the safety valve block (Figure 11-117), and then off the inspiratory (servo) valve Figure 11-118).

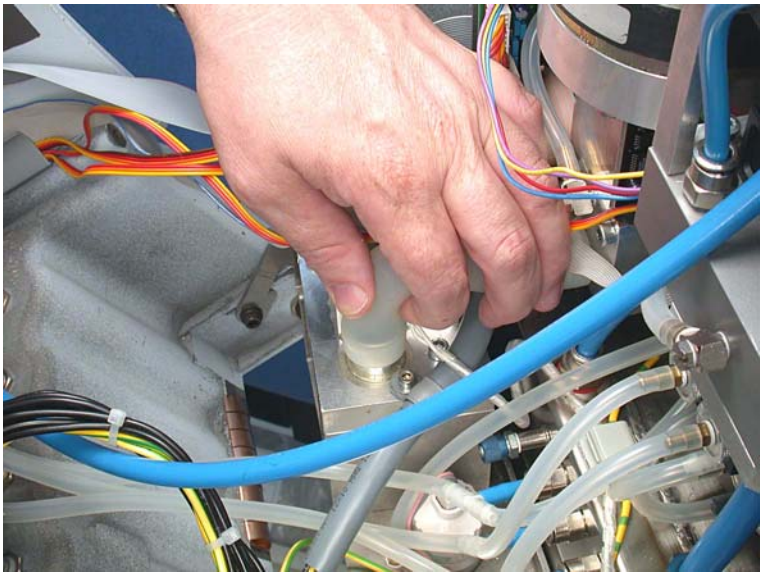


Figure 11-117. Removing the shaped tube from the safety valve block

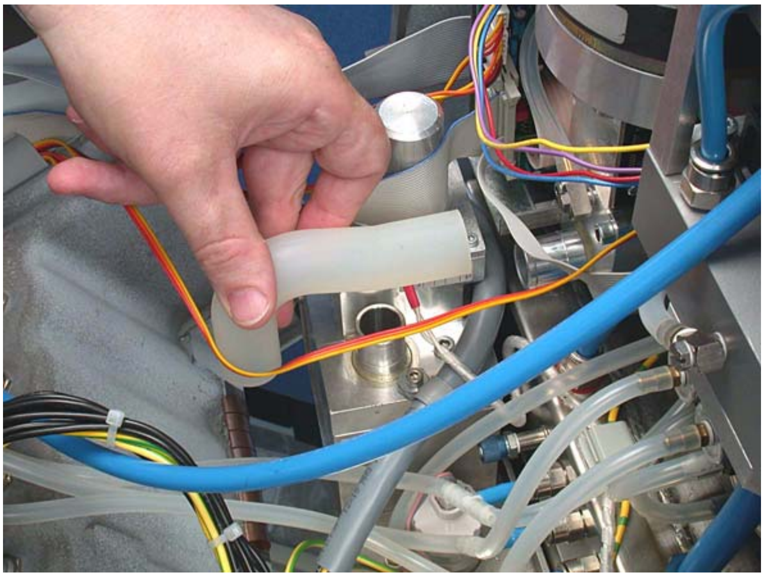


Figure 11-118. The tube removed

5. Remove all electrical connections from the servo board. (Figure 11-119.)

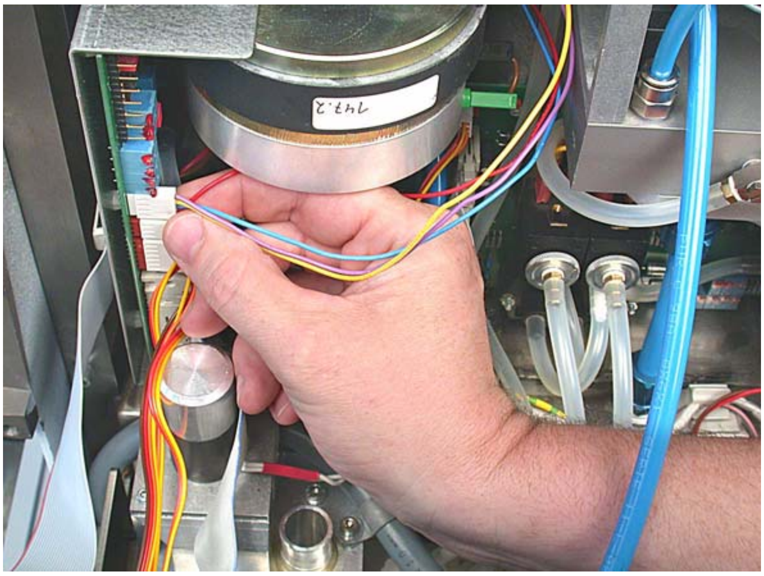


Figure 11-119. Removing the electrical connections from the servo board

6. Remove the two hexagonal-drive (Allen) bolts securing the inspiratory (servo) valve to the tank. (.)

Figure 11-120. **Unscrewing the bolts securing the inspiratory valve**

7. Push the safety valve block forward, remove the inspiratory valve. (Figure 11-121.)

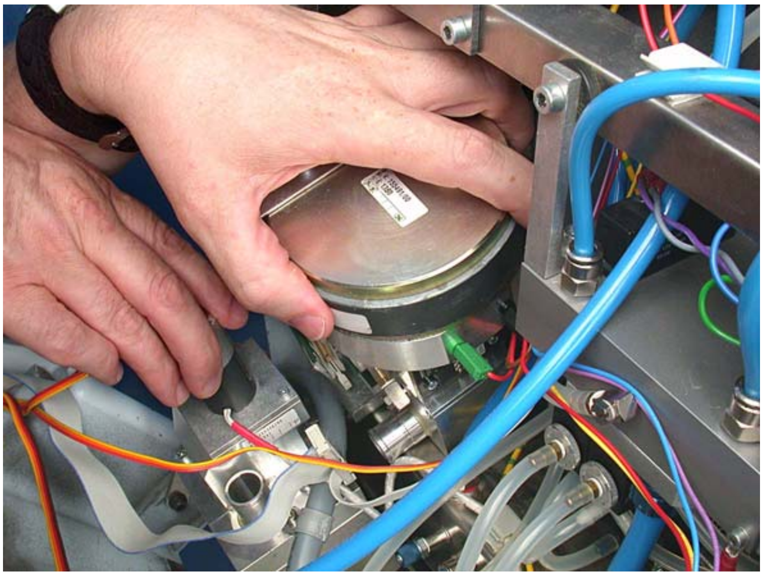


Figure 11-121. **Removing the inspiratory valve**

Fitting the new valve / servo board assembly

Fitting the new inspiratory valve / servo board assembly is essentially a reversal of the removal procedure. However, there are several things to note, as the following procedure explains:

1. Fit the new O-ring, supplied with the new inspiratory valve, into its housing.

CAUTION

The O-ring is vital, to ensure a gas-tight connection with the tank.

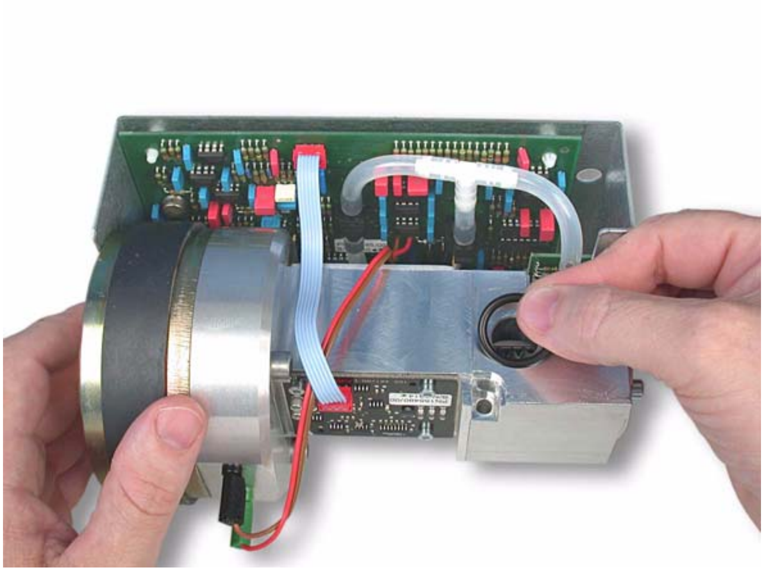


Figure 11-122. Inserting the new O-ring into its location

2. Screw the new valve into place.

CAUTION

You must tighten the screws alternately, in the sequence: screw 1, screw 2, screw 1, and so on. (Figure 11-123.)

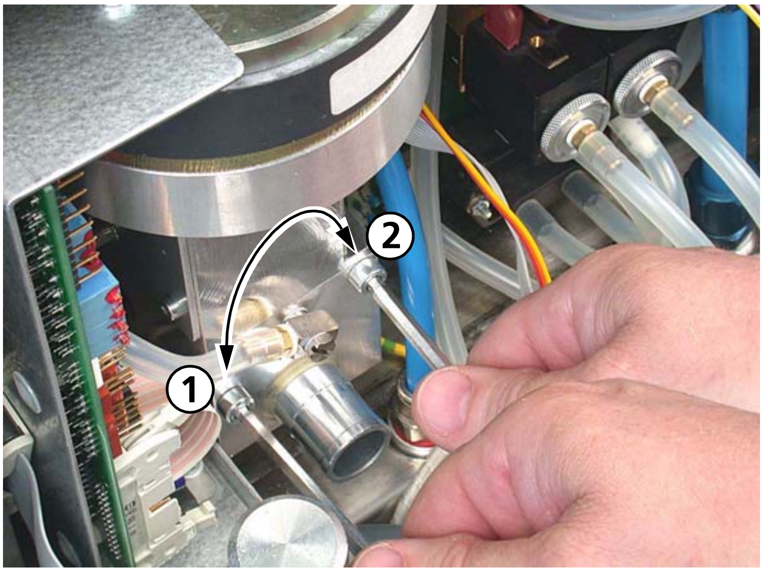


Figure 11-123. Tightening the hexagonal-drive (Allen) bolts alternately

3. Attach the shaped white pneumatic tube and electrical connections. Make sure that all connections are correct. (Figure 11-124.)

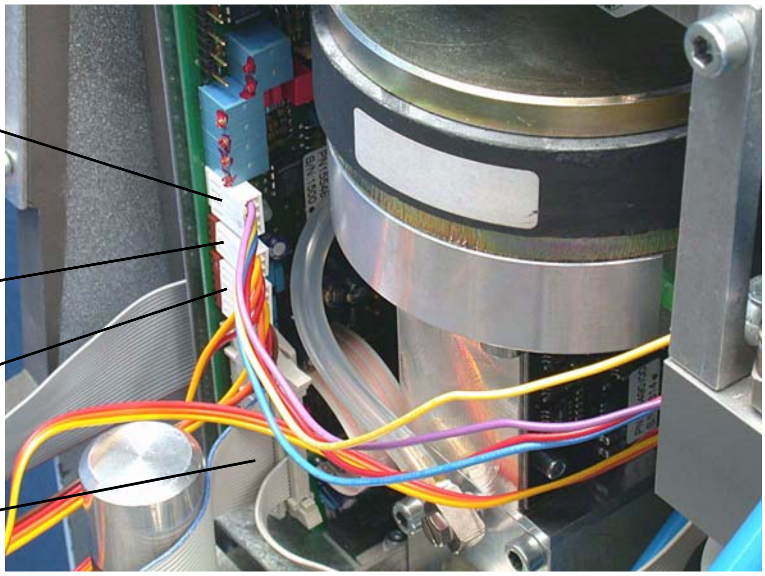


Figure 11-124. The electrical connections to the servo board

4. Screw the safety valve block into place.

Testing

WARNING

You must perform all the following tests.

After fitting a new inspiratory valve / servo board assembly, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
  - Section 9, *Running Original or Upgrade 1 test software*
  - Section 10, *Running Upgrade 2 test software*

11.23 Interface board and GIP EPROM

CAUTION

Do not attempt to repair the interface board. (Although you are permitted to fit a new GIP EPROM). HAMILTON MEDICAL AG does not permit anyone to make any repairs in the field at a level lower than the smallest parts provided in Appendix H, *Spare parts*.

11.23.1 References

- Position in enclosure: Section 3.2, *Components in the front enclosure*, on page 3-2.
- Testing:
  - *TSW 1: GMP Selftest*, on page 9-3.
  - Test 2.3, *Performing the GPT and GMP checks*, on page 9-7
  - Test 2.4, *Performing the LED, LCD, and relay checks*, on page 9-8

  Or:
  - *1: Microprocessor checks*, on page 10-4.
  - Test 2.3, *Performing the GPT and GMP checks*
  - Test 2.4, *Performing the LED, LCD, and relay checks*
- Associated reading:
  - RS232 interface: Appendix B.2, *RS232 interface*, on page B-1.
  - Special interface: Appendix B.3, *Special interface*, on page B-7.
- Part numbers:
  - Interface board: PN 155360, shown in Appendix H.7, *Boards*, on page H-6.
  - GIP EPROM: Appendix D, *Software revisions, features and compatibility*.

11.23.2 Placement

On Upgrade 2 GALILEOs, the interface board is positioned in the front enclosure, on the large metal mounting plate on which the control board is also mounted. This is shown in Figure 11-125 below, and in Figure 3-1, *Components in the front enclosure*, on page 3-2.

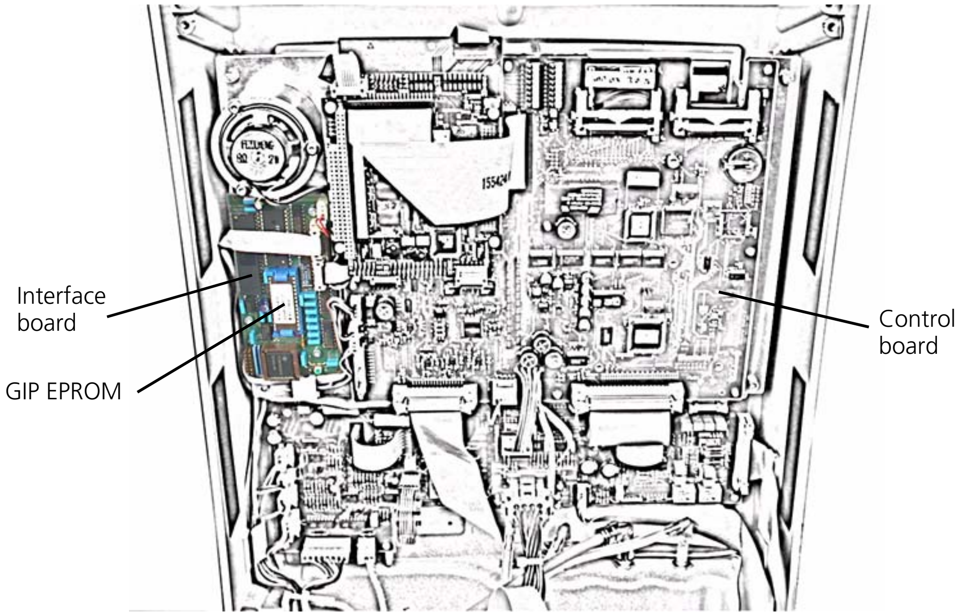


Figure 11-125. Position of the interface board and GIP EPROM in Upgrade 2 GALILEOs

In original and Upgrade 1 GALILEOs, the interface board was mounted in the rear enclosure, as shown in Figure 11-126 on page 11-120.

Note
All versions of GALILEO use the same interface board; it is only mounted in different places in different models.

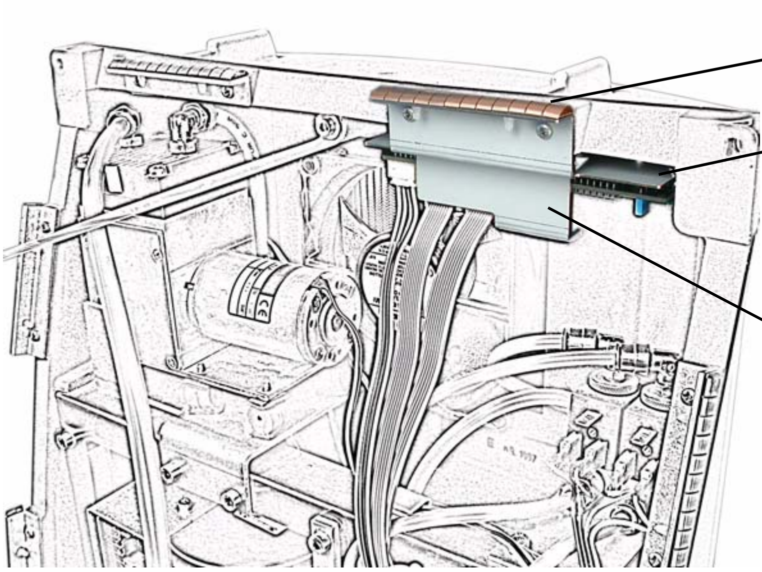


Figure 11-126. Position of the interface board in original and Upgrade 1 GALILEOs

11.23.3 Purpose

The purpose of the interface board is to enable GALILEO to communicate with an external patient monitor, computer, or external alarm system. Fitted on the board is the GIP EPROM that contains the software for the GALILEO Interface Processor, also mounted on the board.

11.23.4 Description and function

11.23.4.1 Interface

The communication interface adds an RS232 and a Special (analog) port, both positioned on a plate at the rear of the GALILEO. (Figure 11-127.)

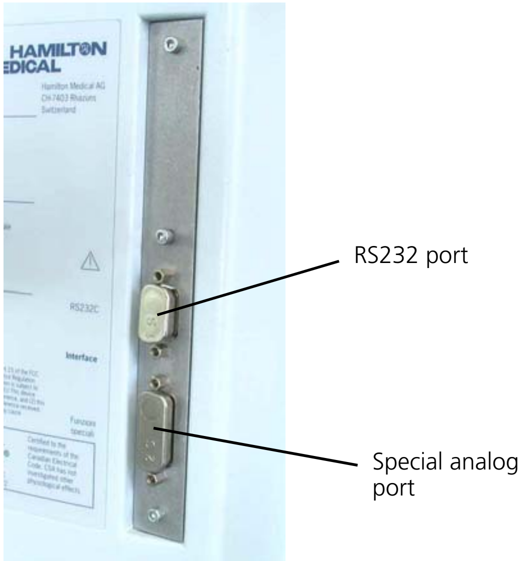


Figure 11-127. The interface plate, shown with dust covers

The RS232 port can be used to communicate with peripherals such as a computer or patient monitor, and the Special port can be used to send an alarm notification to an external nurse alarm, or I:E signals to an external nebulizer or nitric oxide device.

11.23.4.2 GIP EPROM

When using GIP EPROM software revision 01.10 and later, the RS232 port automatically selects either HAMILTON MEDICAL's own proprietary communications protocol, or Philips' VueLink Open Interface protocol. No configuration changes are required of the user.

If using earlier software, the RS232 port can only use HAMILTON MEDICAL's own proprietary communications protocol.

Note

In some circumstances, GIP 01.20 does not operate with some patient monitors. For more information, see Appendix B.2.2.1, *Details of sending data to Philips patient monitors*, on page B-2.

The GIP EPROM software is very easy to update. You simply fit a new GIP EPROM using the GIP EPROM kit documented in the latest version of the HAMILTON MEDICAL *Product Catalog* (PN 689060).

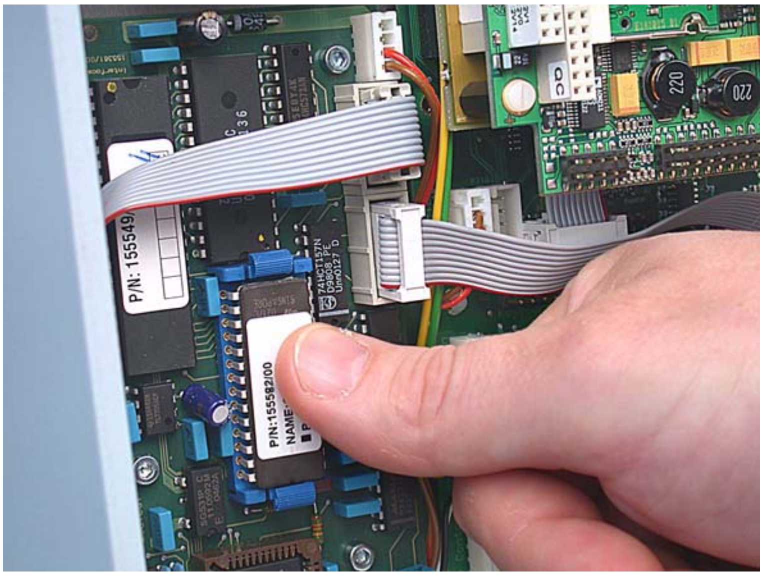


Figure 11-128. Fitting a new GIP EPROM

11.23.4.3 Connecting to patient monitors

When using the HAMILTON MEDICAL protocol, connect external equipment to the RS232 port using 9-pin-male to 25-pin-male serial adaptor, PN 396154 (Figure 11-129). When using the VueLink

Figure 11-129. PN 396154 male to male, RS232 connector for HAMILTON MEDICAL protocol use

Open protocol, connect equipment to the RS232 port with 9-pin-male to 25-pin-female adaptor PN 396129 (of almost identical appearance).

The communication interface facility is documented in the document *Using the GALILEO with Philips monitors and the VueLink Open Interface* PN 610948 and in Appendix B, *Communication interface specifications*.

11.23.5 Further information

For information about troubleshooting using the interface board, see Section 12.3.1, *Control board LED troubleshooting*, on page 12-59.

11.23.6 Replacing the interface board

Removing the old board

To replace the interface board:

1. Open GALILEO's main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
2. Locate the interface board. (Section 11.23.2.)
3. Unplug and unscrew the board.

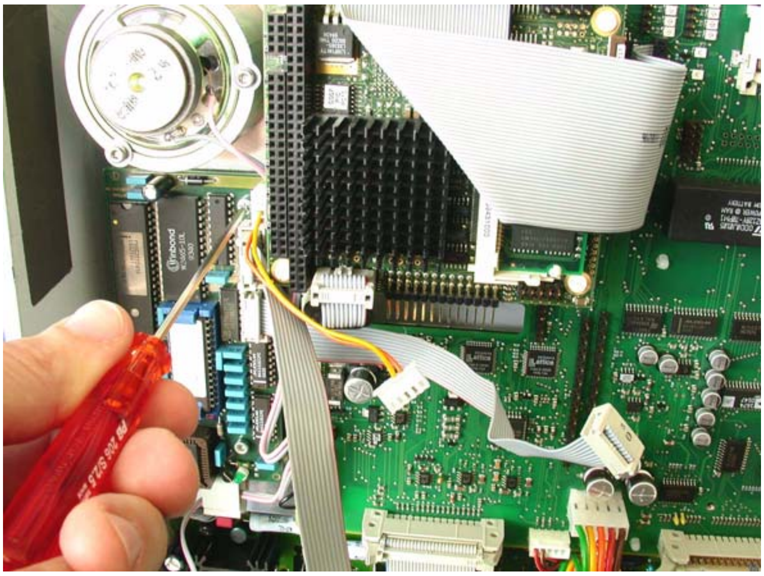


Figure 11-130. Unscrewing the interface board on an Upgrade 2 GALILEO

Fitting the new board

Fitting the new board is simply a reversal of the removal procedure. Be sure that all cables are correctly positioned. (Figure 11-131.)

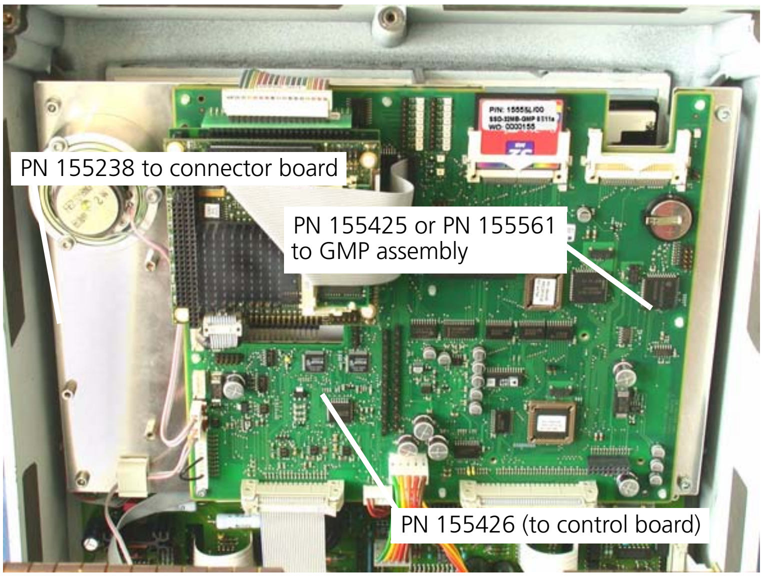


Figure 11-131. Interface board cables in place on Upgrade 2 GALILEO

Note
If you have GMP CPU PN 155499, you require cable PN 155425 to connect to the GMP. If you have GMP CPU PN 396170, you require cable PN 155561 to connect to the GMP.

Testing

WARNING
You must perform all the following tests.

After fitting a new interface board, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
    - Section 9, *Running Original or Upgrade 1 test software*
    - Section 10, *Running Upgrade 2 test software*

11.24 LCD display and backlights

CAUTION

Do not attempt to repair the LCD or backlights. You are only permitted to replace them. HAMILTON MEDICAL AG does not permit anyone to make any repairs in the field at a level lower than the smallest parts provided in Appendix H, *Spare parts*.

11.24.1 References

- Position in enclosure: Section 3.2, *Components in the front enclosure*, on page 3-2.
- Testing and calibrating:
  - TSW 2.4, *Performing the LED, LCD, and relay checks*, on page 9-8.
  - TSW 3.4, *Performing the LCD display color checks*, on page 9-12

  Or:
  - Unit 2.4, *Performing the LED, LCD, and relay checks*, on page 10-11.
  - Unit 3.4, *Performing the LCD display color checks*, on page 10-15.
- Part numbers:
  - LCD display: PN 380017, shown in Appendix H.9, *LCD display components*, on page H-7.
  - Backlights: PN 380022, shown in Appendix H.9, *LCD display components*, on page H-8.

11.24.2 Placement

The LCD display is mounted in the front housing, behind the control board. It cannot be seen unless the control board is removed, as shown in Figure 11-132 below, and in Figure 3-1, *Components in the front enclosure*, on page 3-2. The backlights are part of the LCD display assembly.

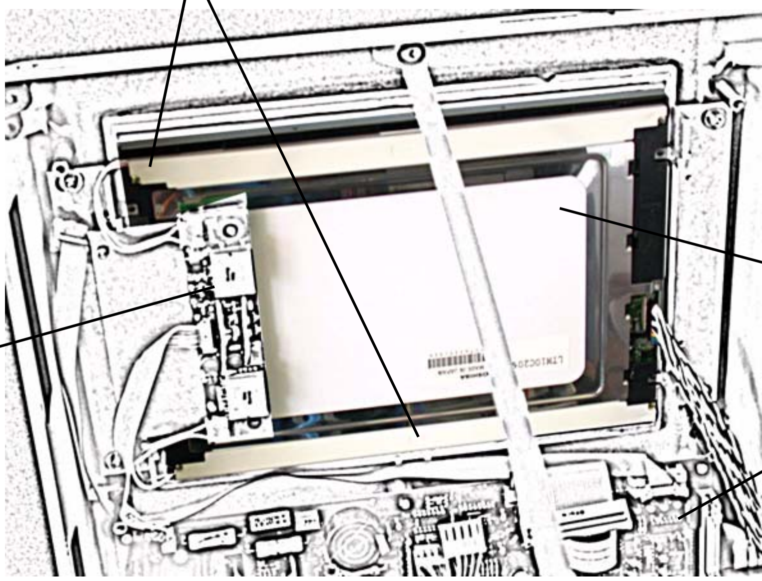


Figure 11-132. The position of the LCD display, shown with control board removed

11.24.3 Purpose

The purpose of the color display is to show:

- Numerics and waveforms from the patient being ventilated.
- Operating modes and settings selected by the user.
- The test software tests used by service engineers.

For more information about the patient data and operating modes displayed by the screen, see the operators' guide for your GALILEO.

For more information about test software tests, see Section 9, *Running Original or Upgrade 1 test software*, on page 9-1, or Section 10, *Running Upgrade 2 test software*, on page 10-1.

11.24.4 Description and function

GALILEO's display is a 10.4 inch, TFT (Thin Film Transistor) color display. It is illuminated by two fluorescent backlights that are built into it, but that can be replaced without removing the display from GALILEO.

The power for the backlights comes from the dc/ac board. This small board is mounted directly behind the LCD, and is documented in Section 11.12, *dc/ac board*, on page 11-61.

11.24.5 Further information

If the display is readable but not bright enough, it is likely that one or more backlights are faulty, or that the dc/ac board is not functioning. Try replacing these items before replacing the display.

11.24.6 Replacing the LCD display and backlights

When you replace the LCD backlights, make a note in the GALILEO test report. You can photocopy one of the following reports from the back of this manual:

- *GALILEO Original and Upgrade 1 Test Report*
- *GALILEO Upgrade 2 Test Report*

Removing the backlights and display

1. Open GALILEO's main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
2. Unscrew the control board mounting plate. (Figure 11-133.)

Note
It is not necessary to remove any cables.

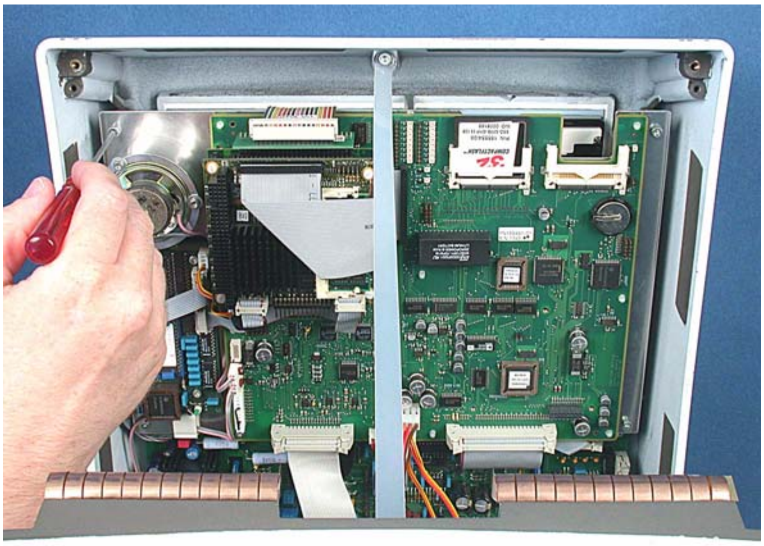


Figure 11-133. Unscrewing the control board mounting plate

3. "Hinge" back the mounting plate, complete with control board. (Figure 11-134.) This exposes the LCD display.

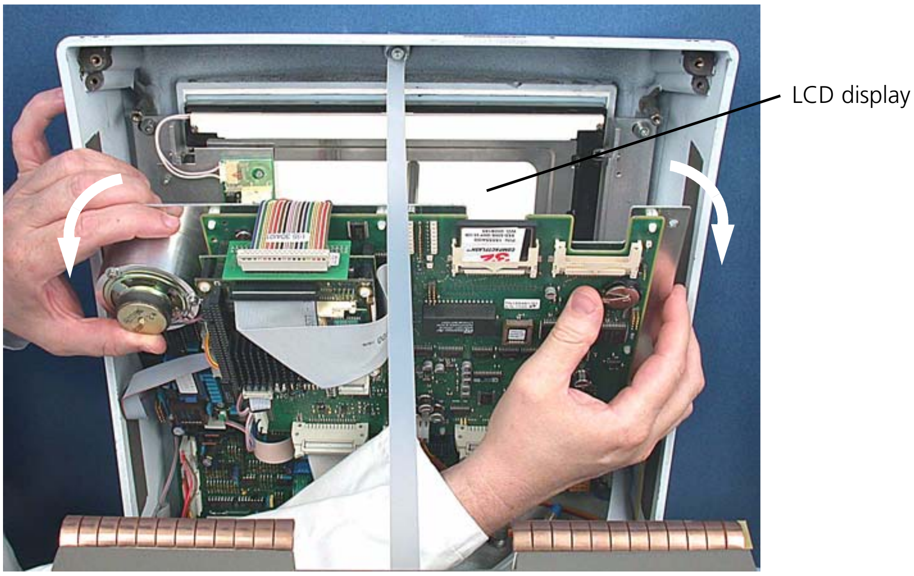


Figure 11-134. "Hinging" the control board back

4. If you must ***remove the LCD display***, go to step (5) on page 11-130 now.
   If you must ***only replace the backlights***, do the following:
   a. Unplug (Figure 11-135), unscrew (Figure 11-136), and lift out (Figure 11-137) both backlights.

Note
Always replace both backlights, even if only one has failed.

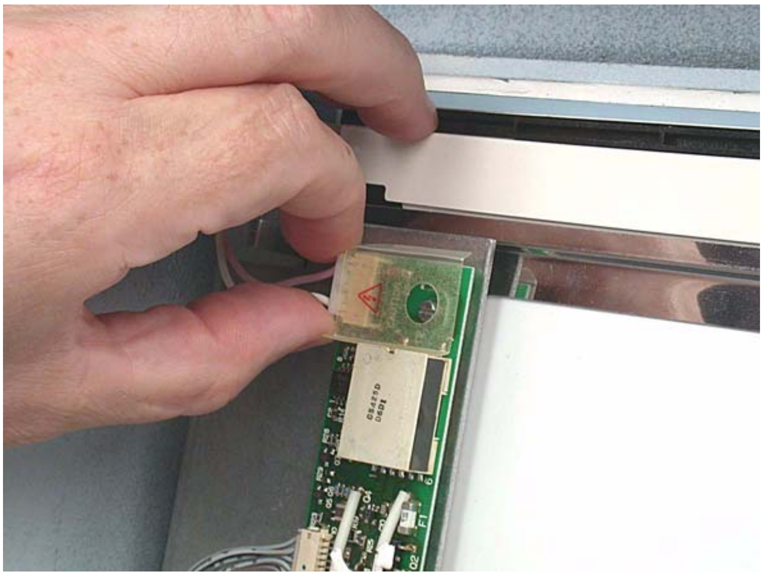


Figure 11-135. Unplugging the upper backlight from the dc/ac board

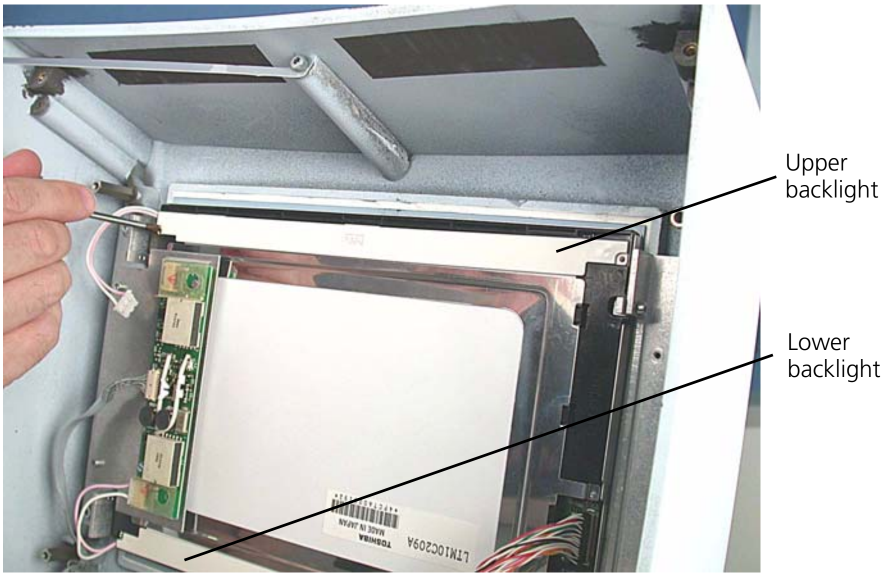


Figure 11-136. Unscrewing the upper backlight

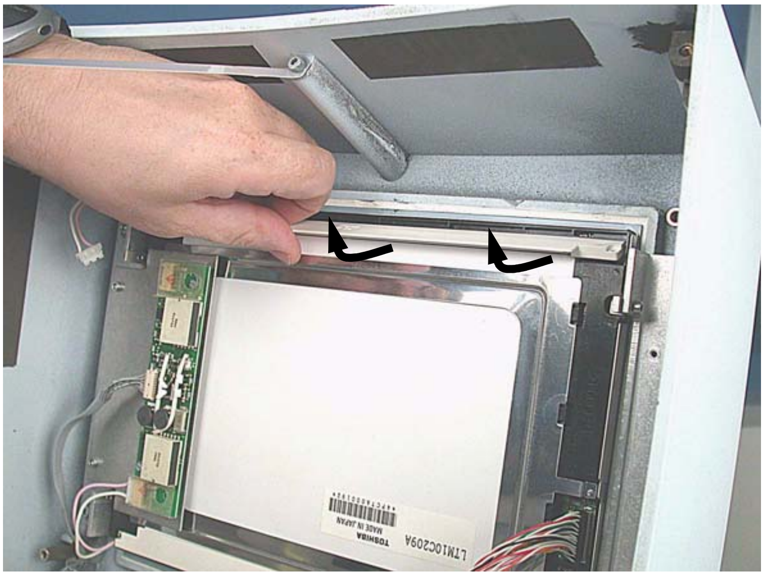


Figure 11-137. Lifting out the upper backlight

b. Fit the new backlights and rebuild GALILEO.

c. Go to *Testing* on page 11-134.

5. If you must remove the LCD display, unplug the cable from the GMP adaptor board from the LCD display. (Figure 11-138 on page 11-130.)

Note
There are different versions of the cable available.

Figure 11-138. **Unplugging the GMP cable from the LCD**

6. Unplug from the dc/ac board, the cable to the interface board.(Figure 11-139.)

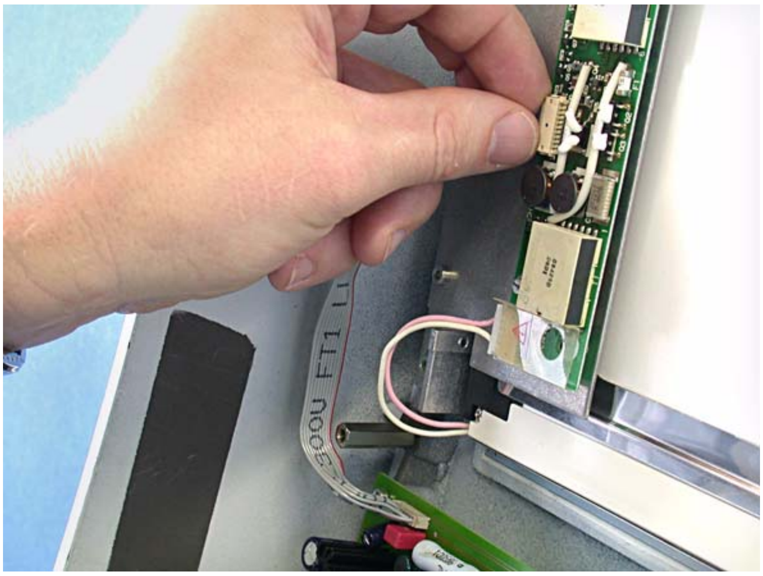


Figure 11-139. **Unplugging the interface board cable from the dc/ac board**

7. Unscrew the four hexagonal-drive (Allen) screws securing the two brackets on which the LCD display is mounted. (Figure 11-140.)

Figure 11-140. Unscrewing the LCD display

8. Lift out the complete assembly. (Figure 11-141.)

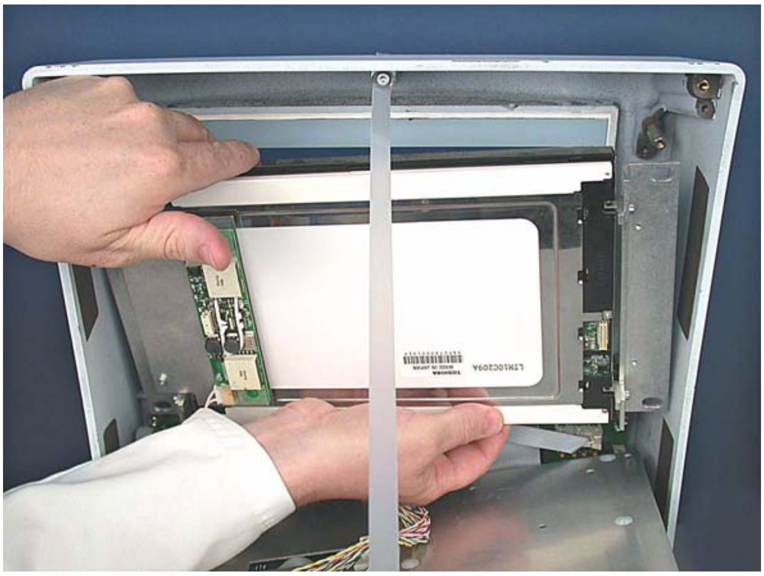


Figure 11-141. Lifting out the complete LCD assembly

9. Unplug both of the lights from the dc/ac board. (.)

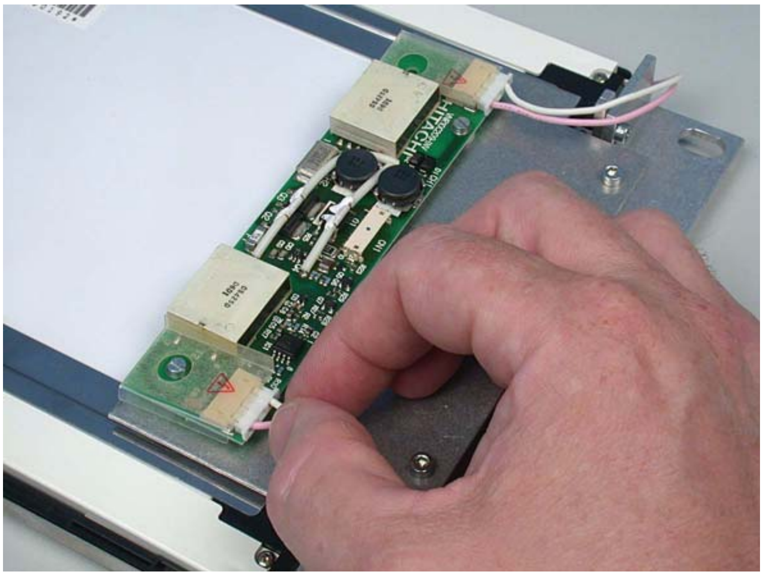


Figure 11-142. Unplugging the lights from the dc/ac board

10. Remove the LCD from the two brackets, by removing the black hexagonal-drive (Allen) screws on the LCD. (Figure 11-143.)

Note
Do not remove the silver hexagonal-drive (Allen) screws on the side of the LCD.

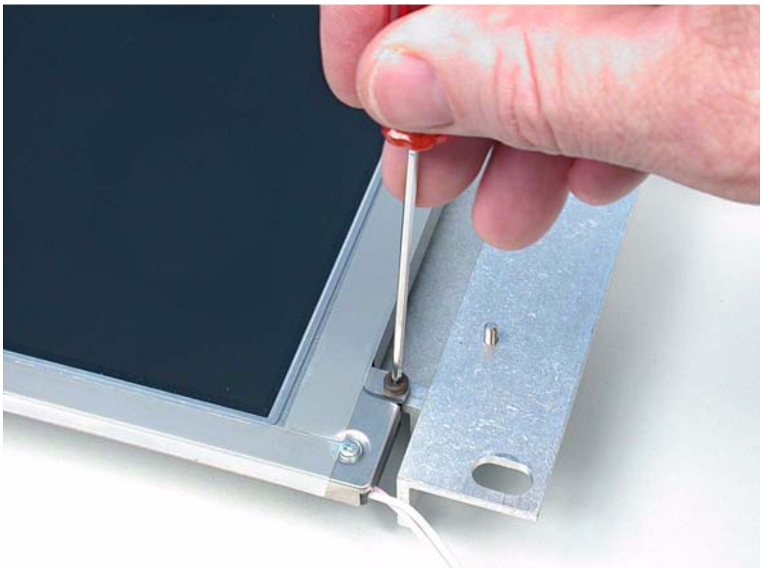


Figure 11-143. Removing the LCD from its brackets

Fitting the new display

To fit the new display, you basically reverse the removal procedure. However, note the following points:

- There must be an offset of approximately 2 mm between the plastic sealing strips on the LCD, and the brackets. (Figure 11-144.)

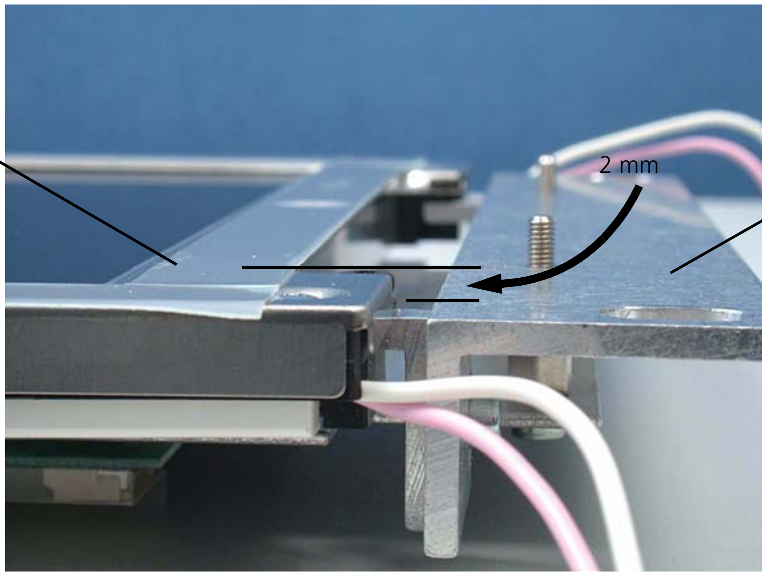


Figure 11-144. Offset between seals and bracket

If necessary, adjust this gap using the silver screws on the side of the LCD. (Figure 11-145.)

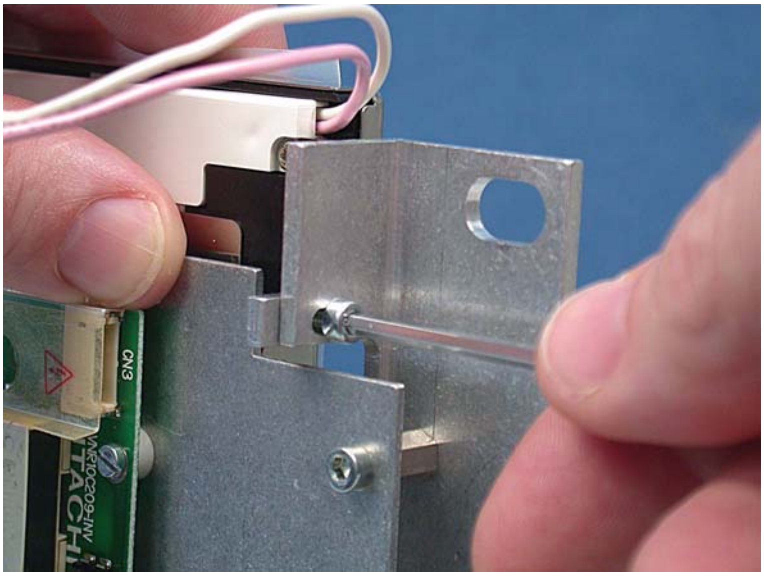


Figure 11-145. Adjusting the offset

- The surface of the LCD must be clean. Wipe it free of finger marks and dust with an antistatic paper towel.

- The cable from the GMP to the LCD display must be in the cable grip on the control board mounting plate. (Figure 11-146.)

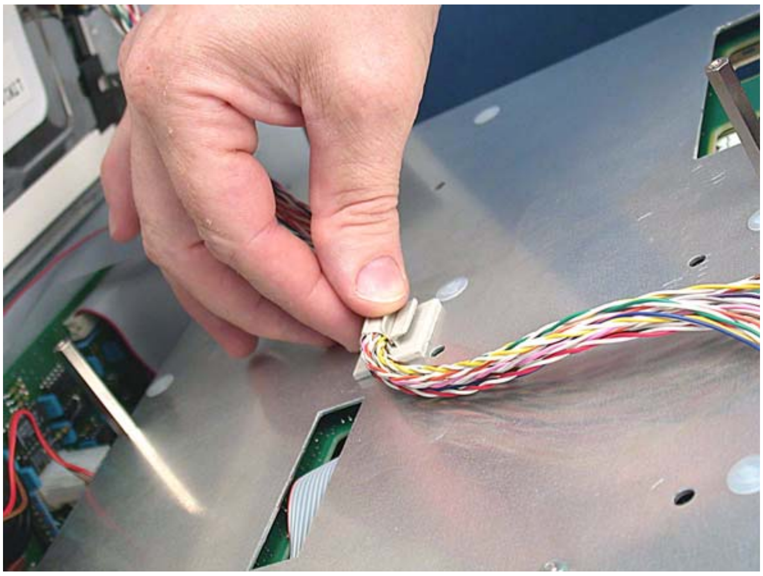


Figure 11-146. Pushing the GMP to LCD cable into its grip

- When screwing the LCD assembly into GALILEO, you must align it with the glass screen in GALILEO. Check this by looking at the front of GALILEO.

Testing

WARNING

You must perform all the following tests.

1. Turn on GALILEO, and make sure that the LCD display lights up, and is properly aligned.
2. Perform the LCD brightness test in one of the following:
   - Test 2.4, *Performing the LED, LCD, and relay checks*, on page 9-8
   - Unit 2.4, *Performing the LED, LCD, and relay checks*, on page 10-11
3. Perform one of the following test units:
   - Test 3.4, *Performing the LCD display color checks*, on page 9-12
   - Unit 3.4, *Performing the LCD display color checks*, on page 10-15

If the above tests are successful, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
  - Section 9, *Running Original or Upgrade 1 test software*
  - Section 10, *Running Upgrade 2 test software*

11.25 Mixer block

CAUTION

Do not attempt to repair components within the mixer block. (Although you are permitted to replace many of them). HAMILTON MEDICAL AG does not permit anyone to make any repairs in the field at a level lower than the smallest parts provided in Appendix H, *Spare parts*.

11.25.1 References

- Position in gas flow:
  - Section 2.2, *Components managing the principle gas flow*, on page 2-2
  - Section 2.3, *Components performing principle pressure and flow measurements*, on page 2-6
  - Section 2.6, *Components monitoring oxygen concentration*, on page 2-18
- Testing and calibrating:
  - TSW 8.4, *Performing the dP mixer zero calibration*, on page 9-32.
  - *TSW 10: Mixer* in Section 9.

  Or:
  - Unit 8.4, *Performing the dP mixer zero calibration*, on page 10-39.
  - *10: Mixer calibration & checks*, on page 10-55.
- Part numbers:
  - Old type mixer assembly: PN 155333, shown in Appendix H.10, *Valves and assembly groups*, on page H-8.
  - New type mixer assembly: PN 155587, shown in Appendix H.10, *Valves and assembly groups*, on page H-9.
  - Mixer valves for both types of mixer assembly: PN 394043, shown in Appendix H.10, *Valves and assembly groups*, on page H-10.
  - One way check valve for old type mixer block PN 155333: PN 279667, shown in Appendix H.10, *Valves and assembly groups*, on page H-9.
  - One way check valve for new type mixer block PN 155587: PN 155715, shown in Appendix H.10, *Valves and assembly groups*, on page H-9.

Note

Part numbers for components of the mixer block are also listed in Appendix H.10, *Valves and assembly groups*.

11.25.2 Placement

There are two models of mixer block: old, PN 155333, and new, PN 155587. Both models are screwed to the chassis, inside the rear enclosure, as shown in Figure 11-147.

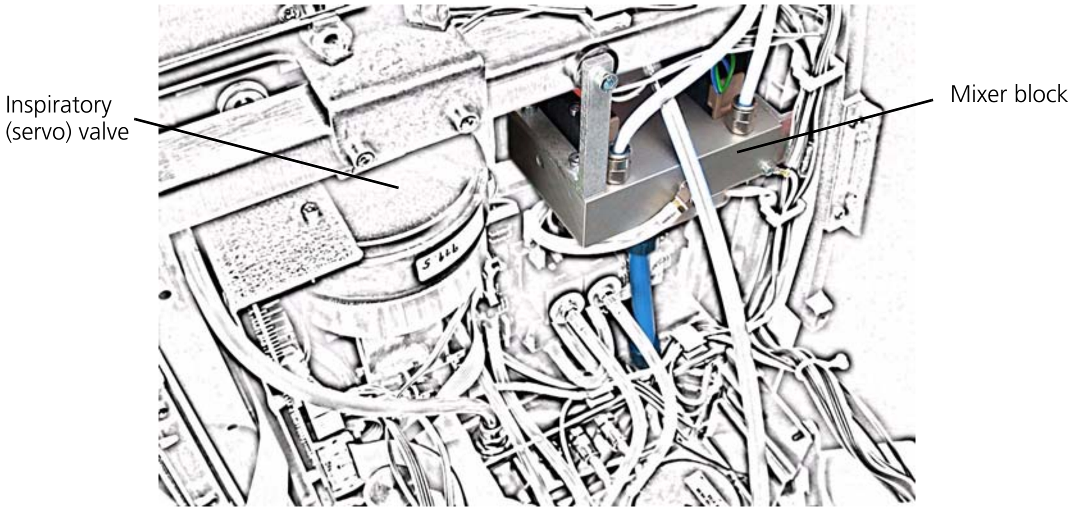


Figure 11-147. Position of mixer block (PN 155333) from inside GALILEO

Similarly, with both models, the rear of the mixer protrudes from the rear enclosure as shown in Figure 11-148.

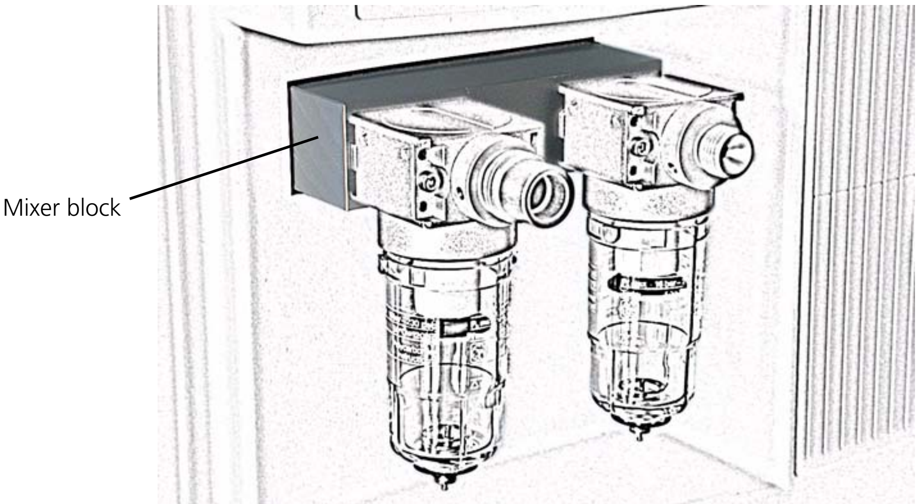


Figure 11-148. Mixer block (PN 155333), with gas inlets, from rear of GALILEO

11.25.3 Purpose

The primary purpose of the mixer block is to measure and control the flow of air and oxygen into the *tank*, thereby regulating the ***gas mixture*** and the ***gas pressure*** in the tank.

Despite its name, the mixing of the gases takes place principally in the tank, not the mixer.

The secondary purpose of the mixer block is to act as a passive pathway for oxygen and air to the *oxygen cell*. (GALILEO requires that the oxygen cell be exposed to both pure oxygen and to air so that GALILEO can calibrate itself for the characteristics of the cell.)

For information about gas flows through the mixer block to the tank in the context of the complete pneumatic system, see:

- Section 2.2, *Components managing the principle gas flow*, on page 2-2.
- Section 2.3, *Components performing principle pressure and flow measurements*, on page 2-6.

For information about the gas flows to the oxygen cell, see:

- Section 2.6, *Components monitoring oxygen concentration*, on page 2-18.
- Section 11.28, *Oxygen cell solenoid valves*.

11.25.4 Description and function

11.25.4.1 Overview

There are two models of mixer block: old, PN 155333 (Figure 11-149), and new, PN 155587 (Figure 11-150). The newer model was phased into production in spring 2006.

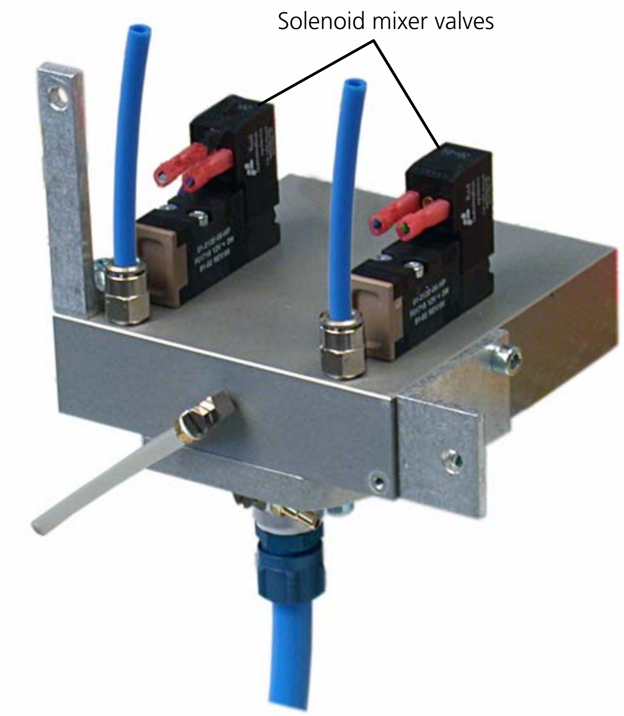


Figure 11-149. Old mixer block PN 155333 (shown from front) without gas inlets

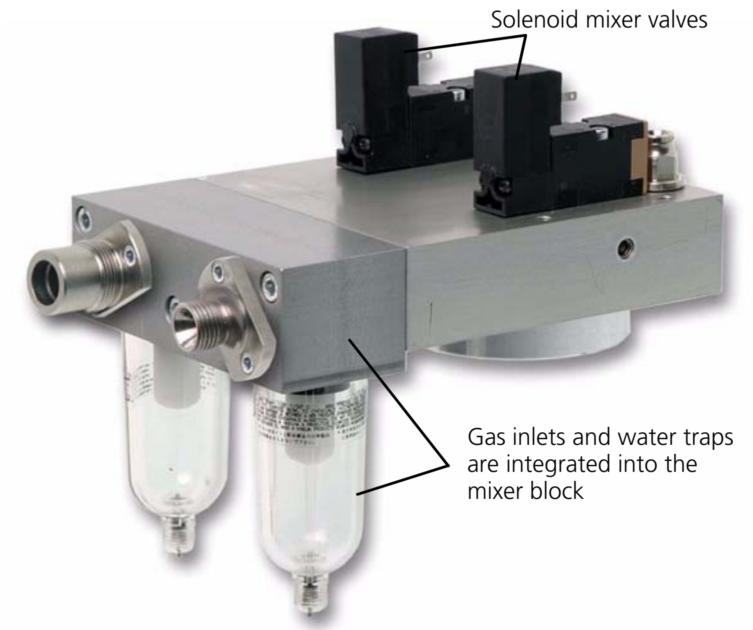


Figure 11-150. New mixer block PN 155587 (shown from rear)

Section 11.25.4.2 describes old mixer PN 155333. The differences between the old block and the new mixer block PN 155587 are explained in Section 11.25.4.3.

11.25.4.2 Mixer block PN 155333: details

Figure 11-151 shows mixer block PN 155333 in exploded view:

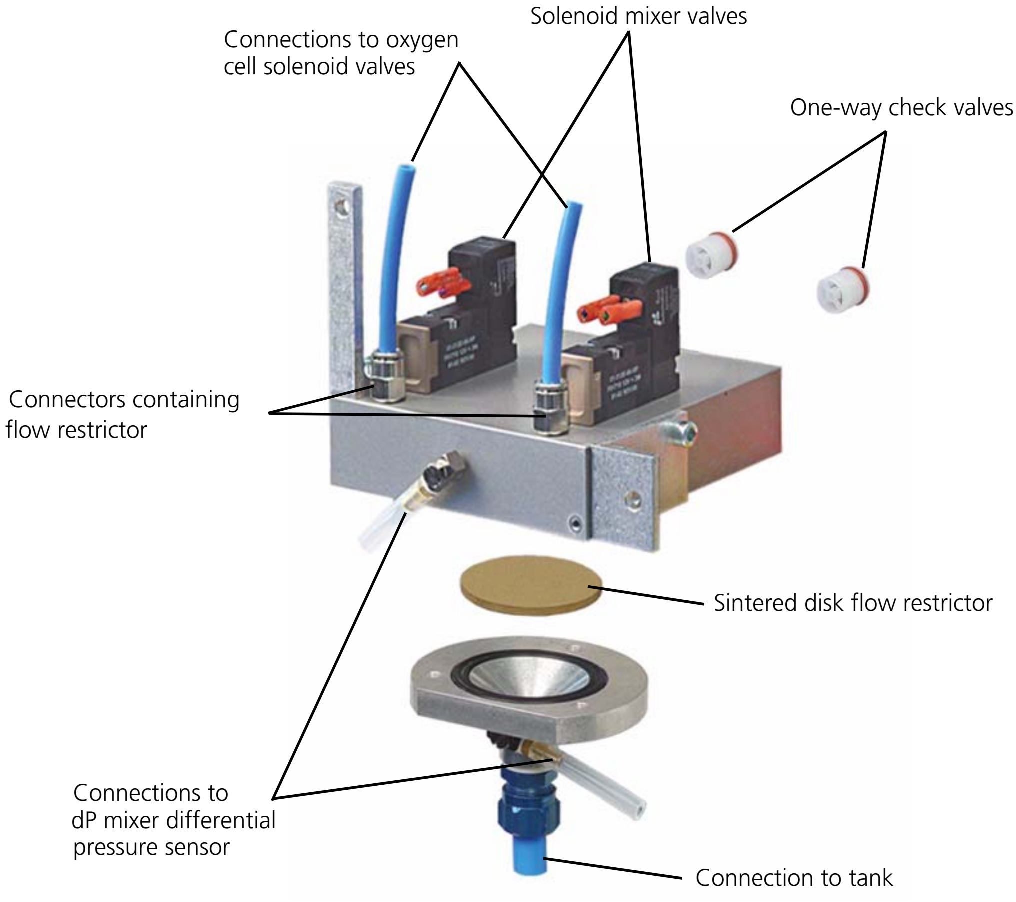


Figure 11-151. Mixer PN 155333 in detail

The following sections deal with each of the components in the mixer.

One-way check valves

There are two kinds of one-way check valve:

- PN 279667 on old type mixer block PN 155333 (Figure 11-153 on page 11-140)
- PN 155715 on new type mixer block PN 155587 (Figure 11-154 on page 11-141)

The purpose of both kinds of one-way check valve is identical: it is to prevent the return flow of gas from the tank into an external gas supply, by means of passing through one of the gas inlet assemblies. Without the check valves, this could happen if one of the external gas supplies failed.

The one-way valves are small components, each located in a housing at the rear of the mixer block immediately behind a gas inlet assembly.

The position of the check valves for old model mixer PN 155333 is shown in Figure 11-152.

Figure 11-152. The one-way check valve for air on old model mixer PN 155333

The check valves for the old model mixer block comprise a plastic sleeve, containing a spring and plunger. (Figure 11-153.)

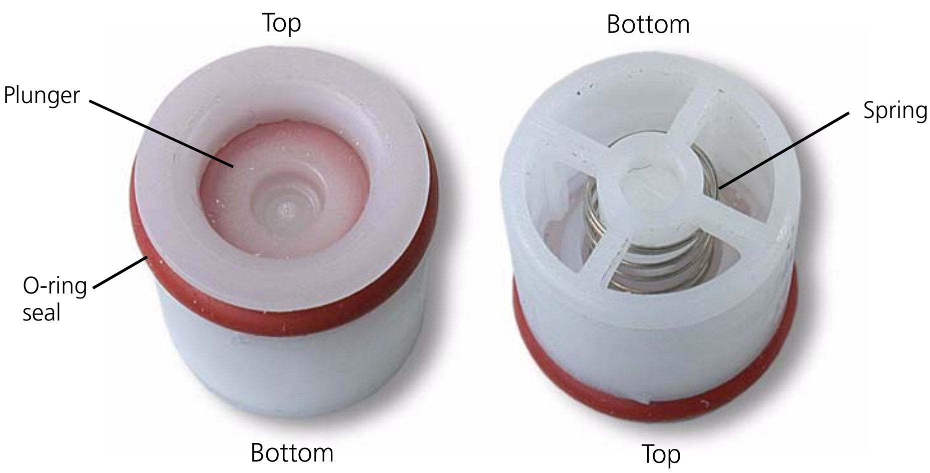


Figure 11-153. Check valve PN 279667 on old model mixer PN 155333

The check valves for the new block have a similar construction, but it is not possible to see the details of the construction. (Figure 11-154 on page 11-141.)

Figure 11-154. Check valve PN 155715 on new model mixer block PN 155587

Both kinds of valve are sealed in place with an O-ring built into the valve.

WARNING

Although the check-valves very seldom fail, they are easily damaged. Do not touch any of these valves unless you are replacing it.

Solenoid mixer valves

The solenoid mixer valves are identical on both old (PN 155333) and new (PN 155587) mixer blocks.

The purpose of the valves is to switch the flow of air and oxygen into the tank (Figure 11-151), thereby controlling:

- The air:oxygen ratio in the tank.
- The pressure in the tank.

In contrast to the inspiratory and expiratory valves, the solenoid valves have only two positions: on and off; they cannot be controlled by degree. They open and close alternately, under the control of the *GCP*, which, in turn, responds to signals from the *dP mixer differential pressure sensor* (see below).

Note

The solenoid mixer valves have no logical connection to the *oxygen cell*. The oxygen cell can monitor the partial pressure of oxygen in the tank, but there is no feedback loop to the solenoid mixer valves.

The mixer valves are not serviceable items, and must be replaced if faulty. They can be damaged by wet or dirty air or oxygen being allowed to enter GALILEO.

Together, the mixer valves, sintered disk flow restrictor, differential pressure sensor and the tank are sometimes known as the mixer.

Sintered disk flow restrictor and dP mixer differential pressure sensor

To control the *mixer valves*, GALILEO must be able to monitor the flow of gas through the mixer block to the tank. (The gas can be oxygen or air, depending on which mixer valve is open.)

GALILEO cannot directly measure the flow of gas through the mixer block, but must calculate the value based on the pressure difference between the chambers above and below a sintered disk flow restrictor (Figure 11-155). This flow restrictor has very carefully defined and tightly specified flow resistance characteristics, and is positioned in the mixer block. The greater the pressure difference across the restrictor, the greater must be the rate of flow causing it.

The measurement of the pressure difference across this flow restrictor is performed by the dP mixer differential pressure sensor, which is positioned on the sensor board. (Figure 11-155.)

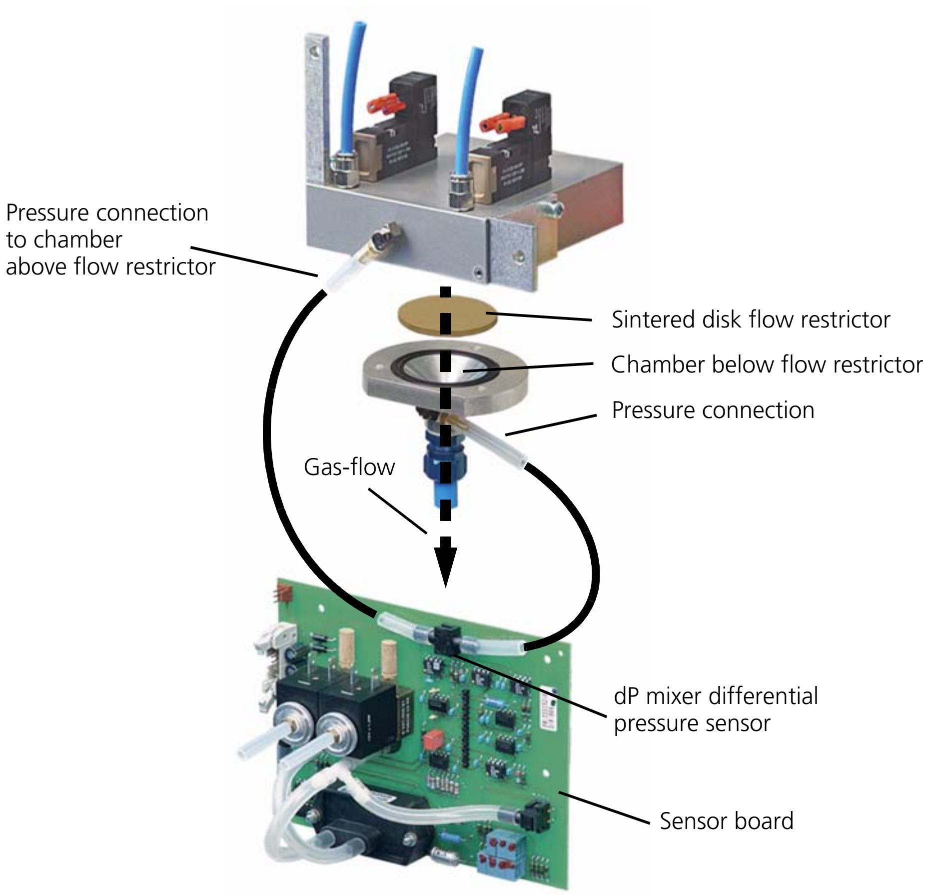


Figure 11-155. The mixer block and dp mixer differential pressure sensor

By measuring the time that a valve is open, and the rate of flow across the flow restrictor, GALILEO can control the quantity of both air and oxygen passing to the tank. In this way, GALILEO can manage both the mixture and the pressure of the gases in the tank.

Note
At no time are the air and oxygen solenoid mixer valves switched on together. Air and oxygen must flow independently, and be measured independently.

Connections to oxygen cell solenoid valves

For more information about these connections (Figure 11-151 on page 11-139), see Section 11.28, *Oxygen cell solenoid valves*, on page 11-168.

11.25.4.3 Mixer block PN 155587: differences

New mixer block PN 155587 functions in exactly the same way as the older model, PN 155333. However, the construction of the block is simpler, thereby reducing costs and increasing reliability.

The main differences between the models are:

- In the new model, the gas inlets and water traps are integrated into the block: they are not separate items screwed to the block. (Compare Figure 11-150 on page 11-138 and Figure 11-152 on page 11-140.)
- In the new model, the NIST and DISS connectors have different fittings for oxygen and air on the ventilator side. It is therefore (almost) impossible to connect the air and oxygen high-pressure inlets incorrectly.
(However, a result of this is that operators that use neither NIST nor DISS connectors, such as some hospitals in France, must redesign their connectors.)
- The tube to the tank is not included with the new mixer type. When replacing an old-type mixer with a new one, order a length of tube PN 7249082, and cut it to a length of 99 mm.

The following table gives a list of old and new part numbers:

Description	Old Mixer	New Mixer
Complete mixer assembly (old type does not include water traps, new type includes water traps).	PN 155333	PN 155587
Sensor board.	PN 155152	PN 155699
NIST connector, O2 (ventilator side).	PN 155207	PN 155700
NIST connector, air (ventilator side).	PN 155206	
NIST kit (air and O2 connectors on ventilator side, air and O2 connectors on hose side, various fittings).	PN 155330	PN 155702
DISS connector, O2 (ventilator side).	PN 155205	PN 155701
DISS connector, air (ventilator side).	PN 155190	
Filter bowl, manual drain.	PN 279729 (1 item included)	PN 155713 (2 items included)
Microfilter element.	PN 279676 (1 item included)	PN 155714 (2 items included)
Gas inlet assembly, for air or oxygen, including base, filter bowl, microfilter element.	PN 279677	The new mixer block has no equivalent.
One-way check valve.	PN 279667 (1 item included)	PN 155715 (2 items included)

Table 11-13. List of replaceable parts

Description	Old Mixer	New Mixer
Flow restrictor 250.	PN 155265 (1 item included)	PN 155716 (2 items included)
Sintered disk for mixer.	PN 153217	PN 155717

Table 11-13. List of replaceable parts

11.25.5 Replacing the mixer block or mixer valves

Note

- The following section shows photographs of the old model mixer block. However, the replacement procedure is almost identical for both old and new models. Where there are differences, they are indicated.
- If you must replace an old model mixer block, order an old model replacement from HAMILTON MEDICAL. (Old models are kept in stock.) Similarly, to replace a new model, order a new model.)

Removing the old mixer block

1. Unscrew and remove the two gas inlet assemblies from the rear of the mixer block. This is shown in Figure 11-152 on page 11-140.

WARNING

Do not touch the two one-way check valves unless you must replace them.

2. Open GALILEO's main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
3. Locate the mixer. (Figure 11-147 on page 11-136.)
4. If you want to replace only the mixer valves, go to step (5).

If you want to replace the complete mixer block, loosen the threaded collar that secures the blue mixer/tank tube to the tank. A 19 mm spanner (wrench) is the ideal tool for this. (Figure 11-156 and Figure 11-157.)

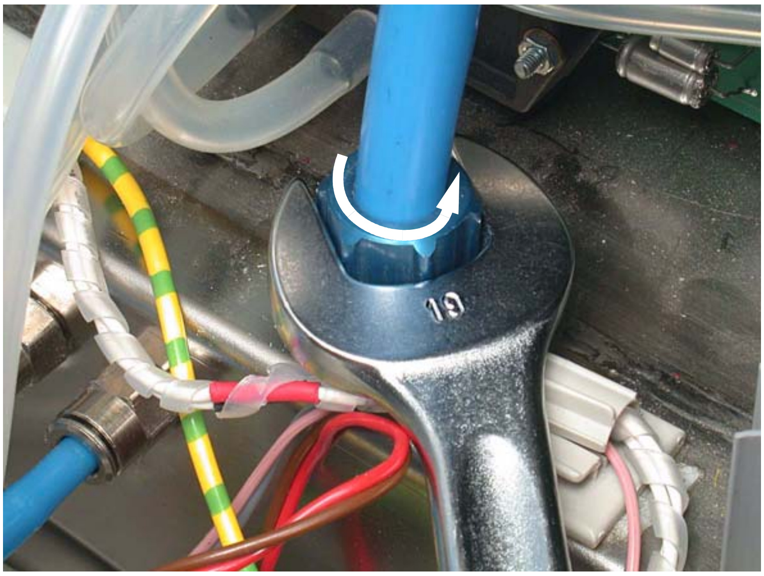


Figure 11-156. Loosening the collar at the tank

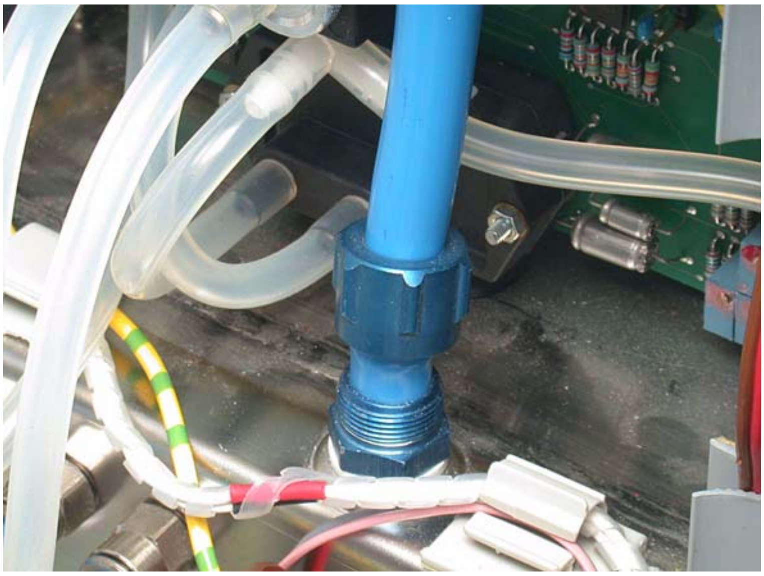


Figure 11-157. The collar fully loosened

5. Remove from the block, the two blue tubes that connect to the oxygen cell solenoid valves. To do this, push down on the inner collar of the connector with a suitable spanner, while pulling up the blue tubing. (Figure 11-158.)

Figure 11-158. Removing one of the oxygen cell solenoid valve connections

6. Remove from the block, the two clear tubes that connect to the sensor board. (Figure 11-159.)

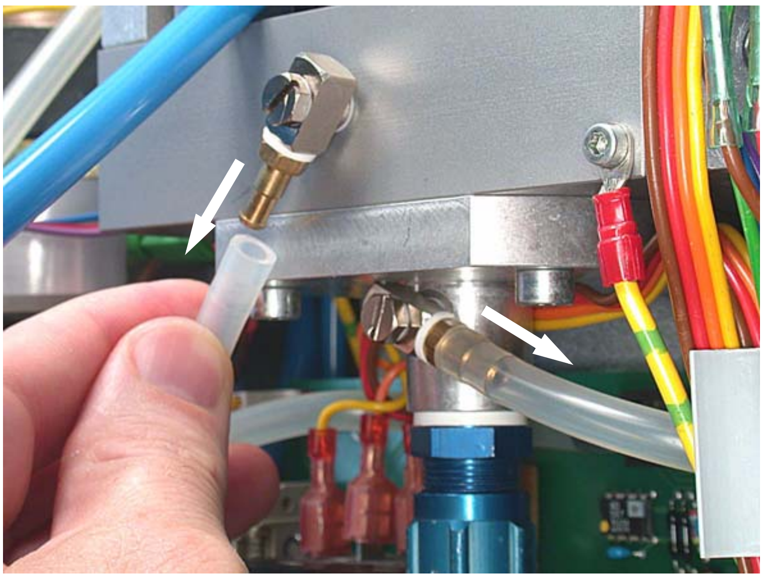


Figure 11-159. Removing the connections to the sensor board

7. Unscrew the grounding (earthing) connection from the block.

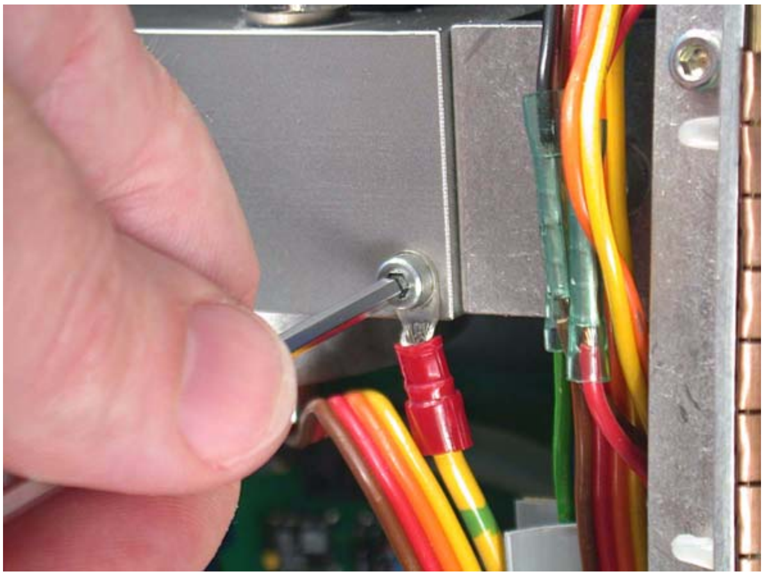


Figure 11-160. Unscrewing the grounding connection

8. Unscrew the two large hexagonal-drive (Allen) bolts securing the block to the chassis.

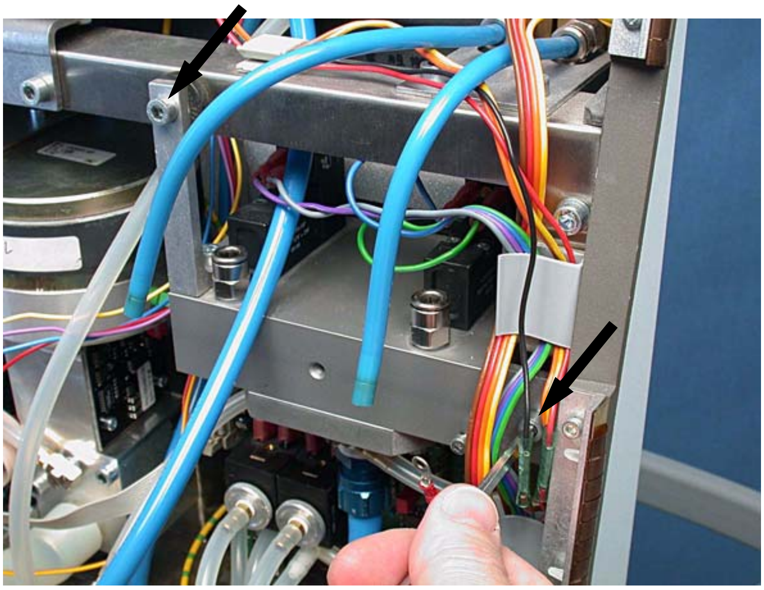


Figure 11-161. Unscrewing the block

9. Slide the upper part of the mixer block slightly to the left and forward.

Note
At this time, the blue tube to the tank is still connected.

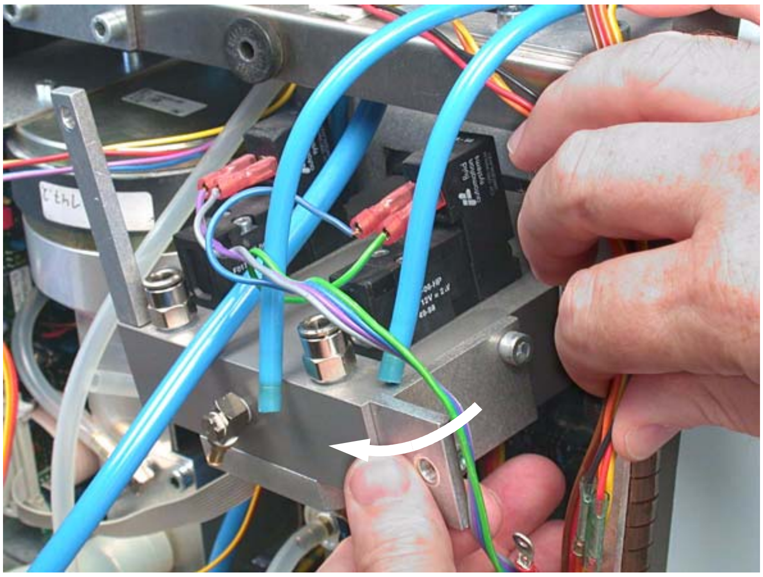


Figure 11-162.

10. If you must only change the solenoid mixer valves, do so now, without separating the mixer block from the tank.

    If you are changing the complete mixer block, remove the electrical connections to the solenoid mixer valves from the old mixer block, and attach them one by one to the new block. (In this way, it is less likely that you will misconnect them.)
11. Carefully pull the mixer block free of the tank.

Figure 11-163. The final stage of removing the mixer block

Fitting the new mixer block

CAUTION

Do not damage the threads on the tank when replacing the mixer block. If you damage the tank, you must replace the complete tank/chassis unit.

Note

When fitting new model mixer block PN 155587 as a replacement for old mixer block PN 155333, you must separately order the block-to-tank tube. Order a length of tube PN 7249082, and cut a part for your use of 99 mm.

Fitting the new mixer block is essentially a reversal of the removal procedure, but note the following points:

- Be patient when screwing the rubber mounting blocks into place. (Figure 11-161 on page 11-147.) Because of the nature of the blocks, the screws can take a long time to go into place.
- Refitting the small blue tubes to the oxygen cell solenoid valves is easier than removing them. Just push the tubes into place. Compare Figure 11-158 on page 11-146 and Figure 11-164 below.

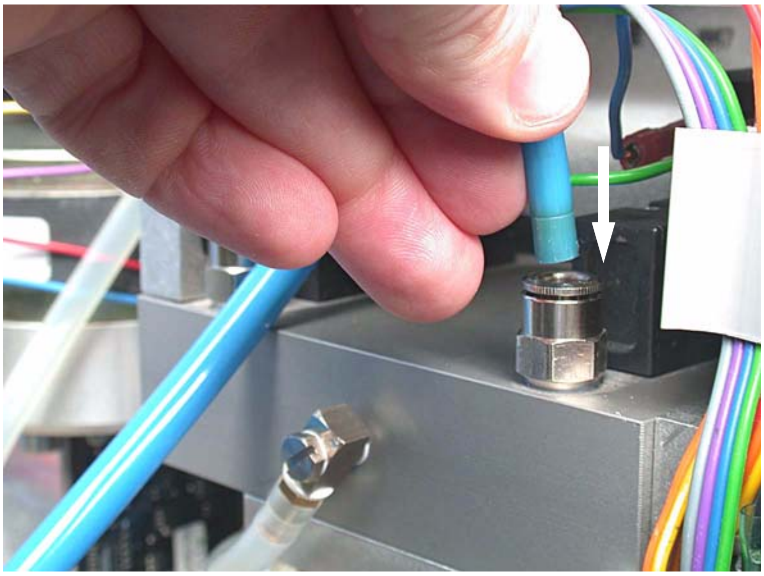


Figure 11-164. **Refitting one of the oxygen cell solenoid valve connections**

11.26 Nebulizer compressor and solenoid valve

CAUTION

Do not attempt to repair the solenoid valve. HAMILTON MEDICAL AG does not permit anyone to make any repairs in the field at a level lower than the smallest parts provided in Appendix H, *Spare parts*.

11.26.1 References

- Position in gas flow: Section 2.7, *Components managing the nebulizer gas flow*, on page 2-20
- Testing:
  - TSW 16.4, *Performing the nebulizer compressor and valve checks*, on page 9-75.

  Or:
  - Unit 16.4, *Performing the nebulizer compressor and valve checks*, on page 10-89.
- Part numbers:
  - Compressor kit: PN 155452, shown in Appendix H.6, *Additional options kits*, on page H-5.
  - Compressor alone: PN 155222, shown in Appendix H.10, *Valves and assembly groups*, on page H-8.
  - Compressor and mounting: PN 155398, shown in Appendix H.10, *Valves and assembly groups*, on page H-9.
  - Solenoid valve: PN 394038, shown in Appendix H.10, *Valves and assembly groups*, on page H-10.

11.26.2 Placement

When fitted, the nebulizer compressor is mounted on the chassis, near the top of the rear enclosure, as shown in Figure 11-165.

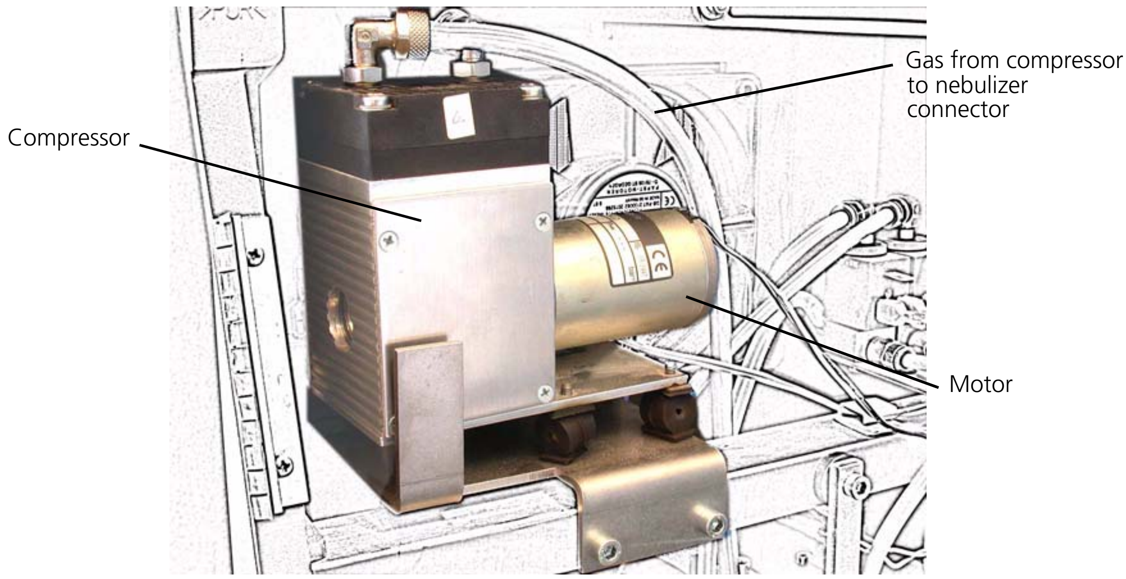


Figure 11-165. The position of the nebulizer compressor (old mounting shown)

Note
The photograph in Figure 11-165 shows an older-style installation, with no protection cage around the compressor. Compare with Figure 11-166.

11.26.3 Purpose

Compressor

The purpose of the nebulizer compressor is to supply an air/oxygen mixture at a sufficient pressure to drive an external nebulizer.

For information about gas flows through the nebulizer compressor in the context of the complete pneumatic system, see Section 2.2, *Components managing the principle gas flow*, on page 2-2.

Nebulizer solenoid valve

The purpose of the solenoid valve is to control the flow of gas from the tank to the nebulizer compressor.

Note
The valve is positioned between the tank and the nebulizer compressor, not between the nebulizer compressor and the nebulizer.

11.26.4 Description and function

The nebulizer compressor is supplied with the air/oxygen mixture from the tank at a pressure of 200 to 340 mbar. The compressor increases this to about 900 mbar, which is a sufficient pressure to supply a nebulizer.

Using the location photograph (Figure 11-165) together with the end-view photograph (Figure 11-166) it is possible to see the following three main parts in reasonable detail:

- Motor
- Compressor

- Solenoid valve

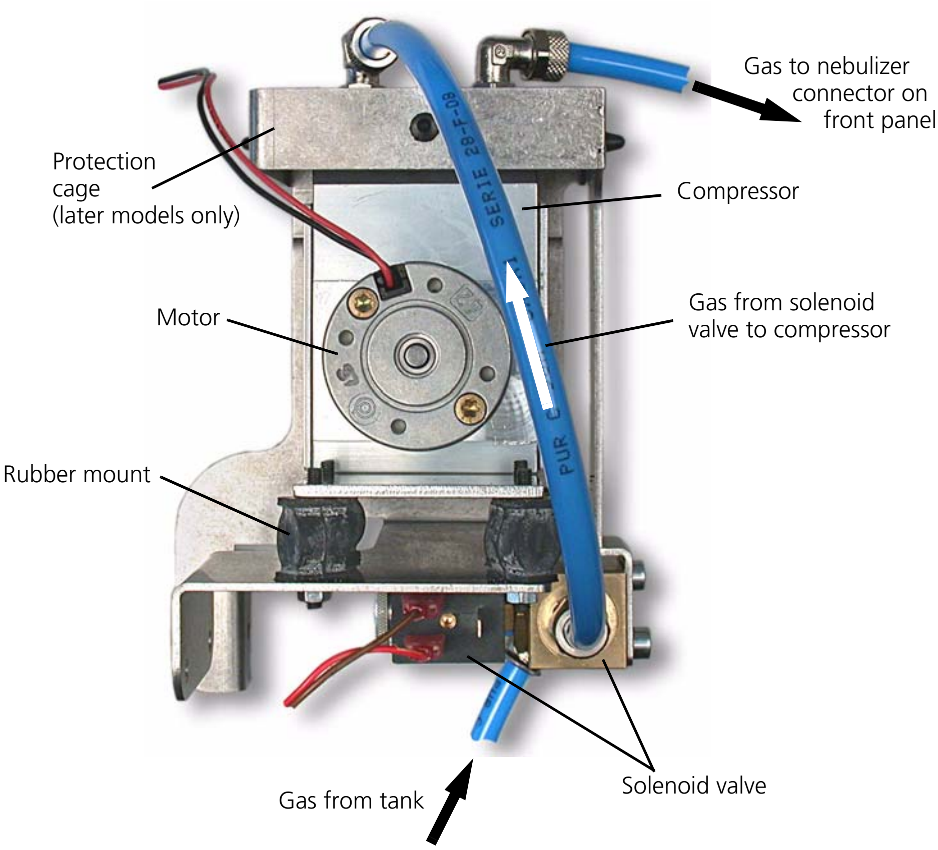


Figure 11-166. The nebulizer compressor from the right (new mounting shown)

Note
The photograph above shows the newer-type installation, with the protection cage.

When nebulization is not required, GALILEO supplies no power to the compressor and solenoid valve. In its unpowered state, the solenoid valve is in its "off" position: this means that gas from the tank cannot pass through the unpowered compressor to the nebulizer. When nebulization is required, both valve and compressor are activated.

For more information about the construction of the compressor, see Section 11.26.6, *Maintaining or replacing the nebulizer compressor and solenoid valve*.

11.26.5 Further information

GALILEO takes the gas that it supplies to an external nebulizer jar directly from the mixture in GALILEO's tank. This method has the advantage of not disrupting the air:oxygen ratio of the gas that GALILEO delivers to the patient.

Furthermore, during nebulization, GALILEO automatically reduces the flow of gas through the inspiratory valve, thereby compensating for the additional flow of gas delivered to the patient by the nebulizer. This means that the flow of gas to the patient always matches the patients requirements and the user settings, with or without nebulization.

Depending on how it is configured, the nebulizer compressor provides gas to the nebulizer during inspiration, during exhalation, or during both inspiration and exhalation. For information about configuring the nebulizer compressor, see the appropriate operators' manual for your GALILEO.

The nebulizer compressor is an option.

11.26.6 Maintaining or replacing the nebulizer compressor and solenoid valve

Maintenance

The nebulizer compressor is one of the few of GALILEO's components on which you can perform maintenance.

Maintenance takes the form of replacing the following parts when required by the schedule in Section 6.1, *Engineer preventive maintenance*, on page 6-1, or when the nebulizer fails to function properly:

- Membrane
- Flaps
- O-rings

The kit containing these parts is PN 399097, shown in Appendix H.19, *Miscellaneous*, on page H-27.

To perform maintenance, go to Section 11.26.6.1, *Removing the nebulizer compressor*.

When you overhaul the nebulizer compressor, make a note in the GALILEO test report. You can photocopy one of the following reports from the back of this manual:

- *GALILEO Original and Upgrade 1 Test Report*
- *GALILEO Upgrade 2 Test Report*

Replacement

When instructed by a troubleshooting section in either Section 9, *Running Original or Upgrade 1 test software* or Section 10, *Running Upgrade 2 test software*, you must sometimes replace the nebulizer compressor or the solenoid valve.

To make either of these replacements, go to Section 11.26.6.1, *Removing the nebulizer compressor*.

11.26.6.1 Removing the nebulizer compressor

1. Open GALILEO's main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
2. Locate the nebulizer compressor. (Section 11.26.2.)

3. Remove from the connector board, the two cables running from the nebulizer compressor to the connector board. (One comes from the motor, one from the valve situated behind the compressor). (Figure 11-167.)

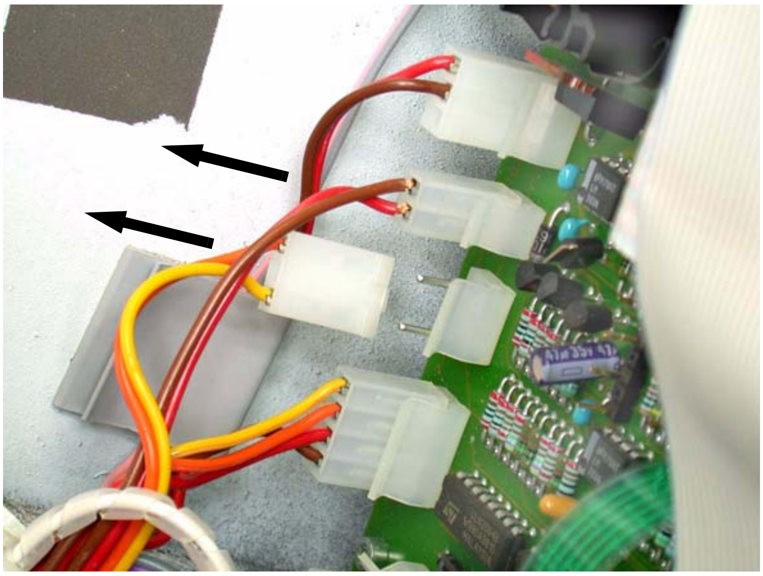


Figure 11-167. Removing the cables from the connector board

4. Remove the cables from the cable grips. (One grip comprises two parts, as shown in Figure 11-168. You open it by "unbending" the two plastic wings as indicated by the arrow in the photograph.)

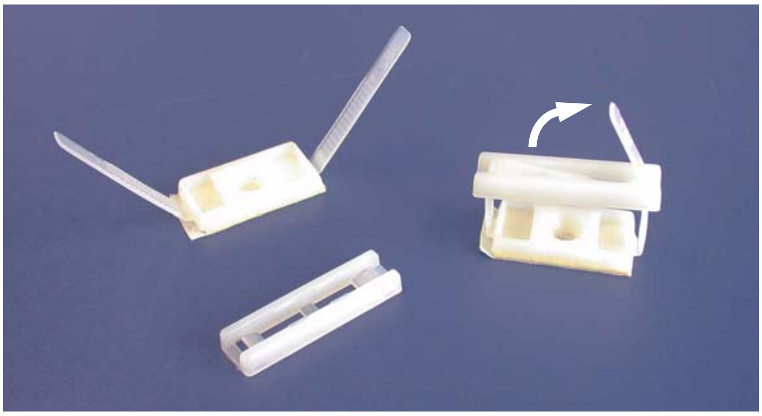


Figure 11-168. The construction of cable grip PN 361025

5. Note how the two blue pneumatic hoses from the nebulizer compressor are routed.

6. Remove one hose from the connector on the front panel. To do this, use a wrench to push down on the inner collar of the connector, while pulling the tube free. Figure 11-169 shows the removal of the hose from the tank.

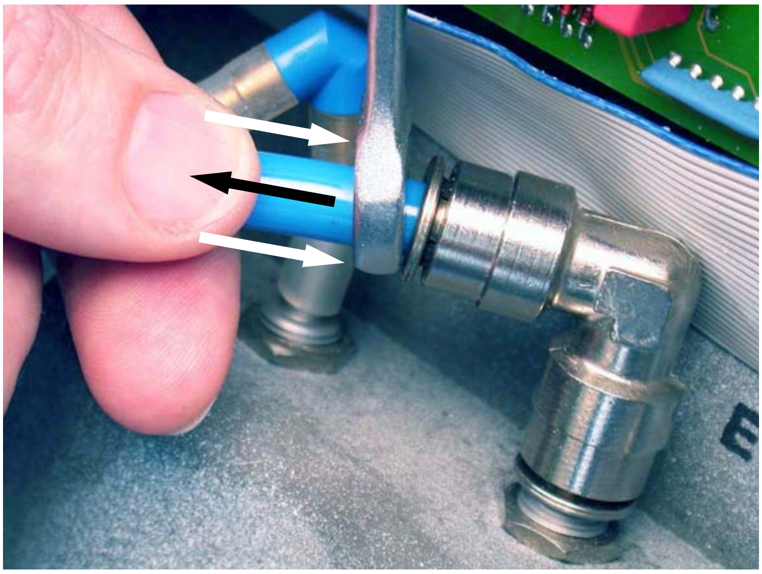


Figure 11-169. **Removing the nebulizer hose from the front panel**

7. Now disconnect the hose from the tank in the same way.

Note
Do not disconnect either hose from the nebulizer compressor.

Figure 11-170. **The nebulizer connection to the tank**

8. Unscrew the two hexagonal-drive (Allen) screws securing the nebulizer compressor to the chassis. (Figure 11-171.)

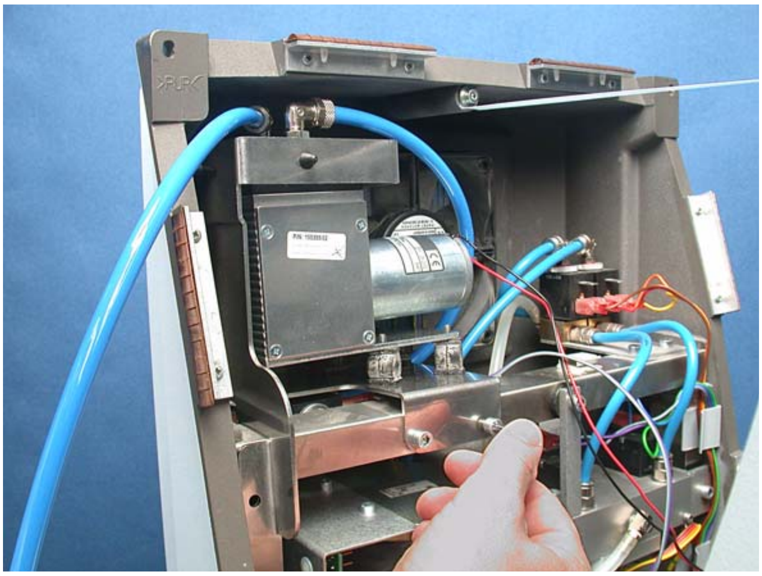


Figure 11-171. Unscrewing the nebulizer compressor

9. Remove the compressor. (Figure 11-172.)

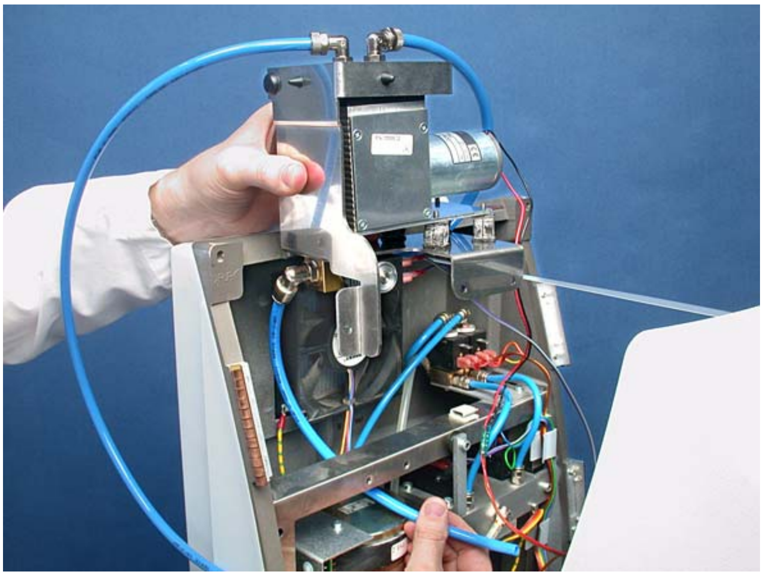


Figure 11-172. Removing the nebulizer compressor

11.26.6.2 Further action

You must now do one of the following:

- Perform maintenance and replace the compressor. To do this, go to Section 11.26.6.3, *Performing maintenance*.
- Replace the solenoid valve. In this case, replace the valve now, and then go to Section 11.26.6.4, *Fitting the new or refurbished nebulizer compressor*.

- Fit a new compressor. To do this, go to Section 11.26.6.4, *Fitting the new or refurbished nebulizer compressor*.

11.26.6.3 Performing maintenance

1. Disconnect the shorter of the pneumatic hoses from the top of nebulizer compressor. (The longer hose can remain connected to the compressor.) With older models of compressor, you use a wrench to push down on the inner collar of the connector. With newer models, you unscrew the collar as shown in Figure 11-173.

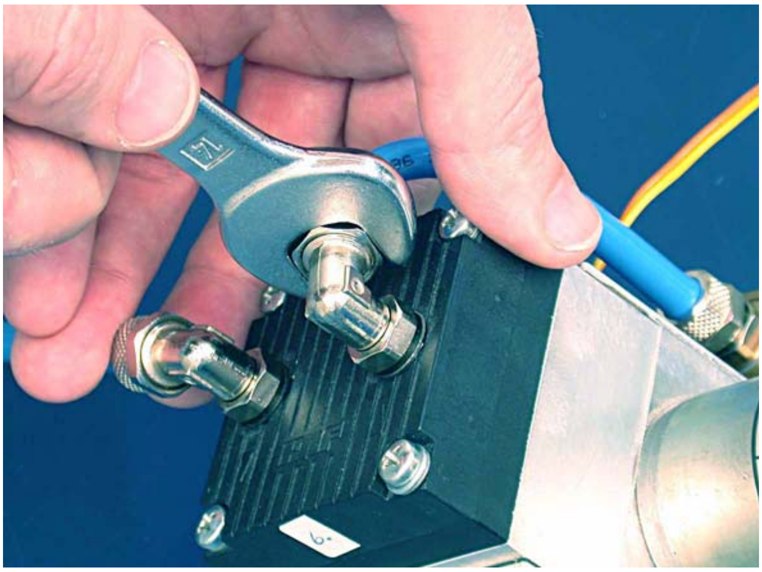


Figure 11-173. Unscrewing the shorter hose from a new model compressor

2. Remove the top of the compressor by unscrewing the four cross-head screws. (Figure 11-174.)

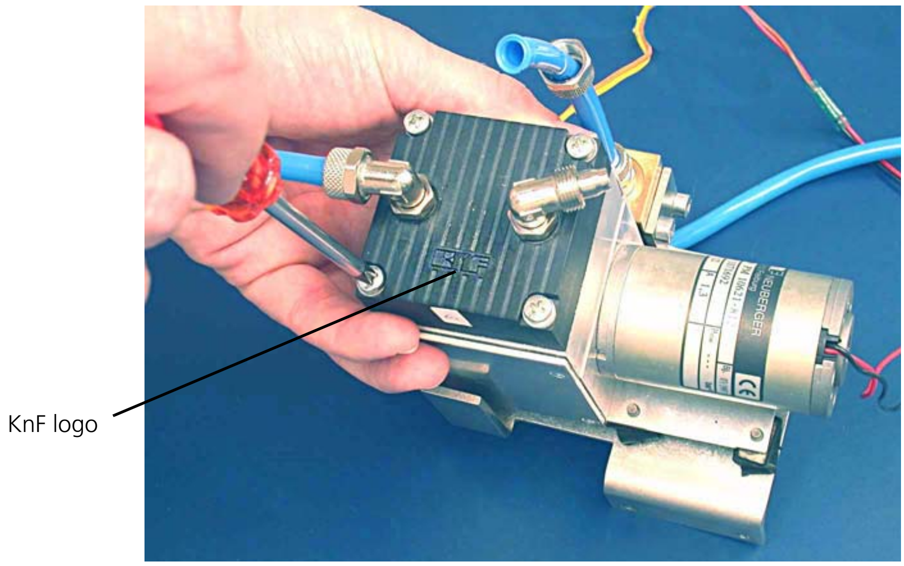


Figure 11-174. Removing the top of the compressor

3. Unscrew the membrane that comprises the “piston”. To do this, first access an edge of the membrane by levering it up with a small screwdriver. (Figure 11-175.)

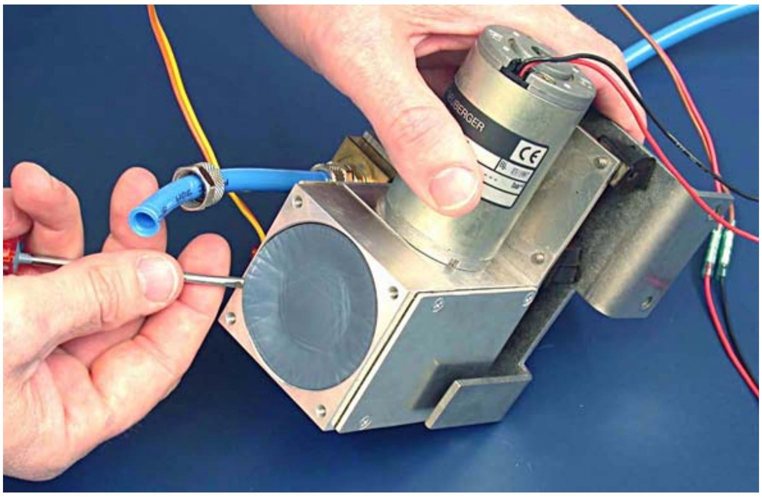


Figure 11-175. Levering up the membrane

Then, taking a grip of both sides, unscrew and remove the membrane. (Figure 11-176.) Make sure you do not lose any washers that may be in place on the thread.

Figure 11-176. Unscrewing the membrane

4. Fit the new membrane, making sure that you replace the old washers, and that you screw the membrane fully home.

5. Remove the old flaps and O-rings, and carefully position the new flaps and O-rings on the valve block. (Figure 11-177.)

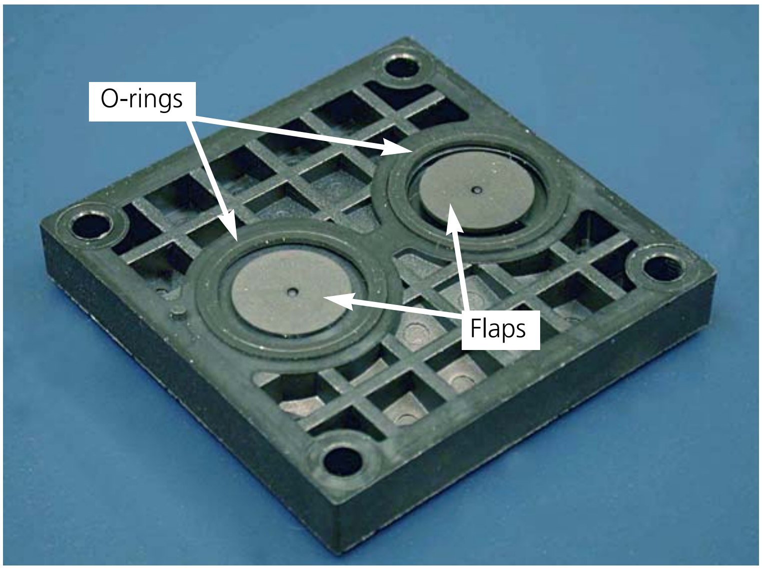


Figure 11-177. The new flaps and O-rings positioned on the valve block

6. Place the valve block on top of the compressor, making sure that the location lug is positioned away from the motor. (Figure 11-178.) .

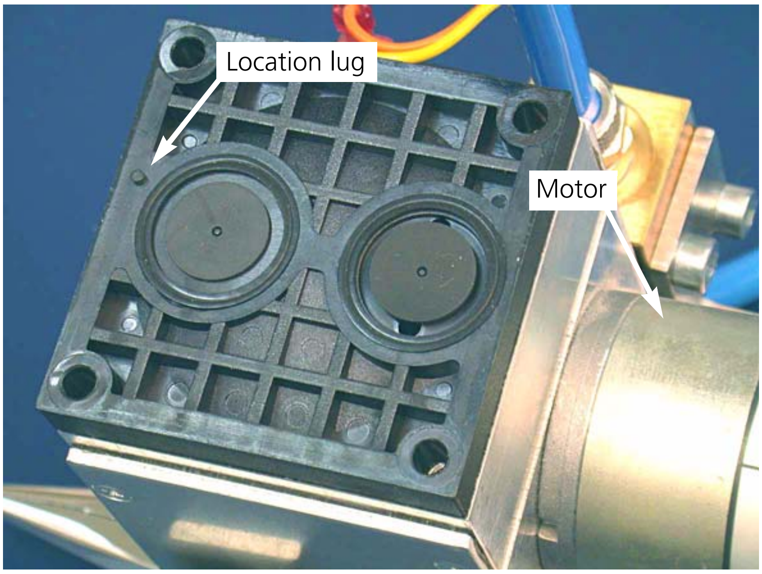


Figure 11-178. The valve block, correctly positioned on the compressor

7. Refit the top of the compressor, making sure that the letters **Knf** embossed on the top are positioned towards you. (See Figure 11-174, *Removing the top of the compressor*, on page 11-157.)
8. Refit the shorter pneumatic hose to the top of the compressor. A small amount of silicon grease applied to the ***outside*** of the hose enables the collar to turn without twisting the hose. (See Figure 11-173, *Unscrewing the shorter hose from a new model compressor*, on page 11-157.)

11.26.6.4 Fitting the new or refurbished nebulizer compressor

To fit the new nebulizer compressor, reverse the removal procedure.

You must route the blue pneumatic hoses before screwing the nebulizer compressor into place. Both hoses must be placed ***behind*** the nebulizer mounting bar. The shorter hose, to the reservoir tank, must also be positioned behind the inspiratory valve.

You do not need a wrench to refit the blue pneumatic hoses to the nebulizer connector and the reservoir tank: they are a push fit. (Figure 11-179.)

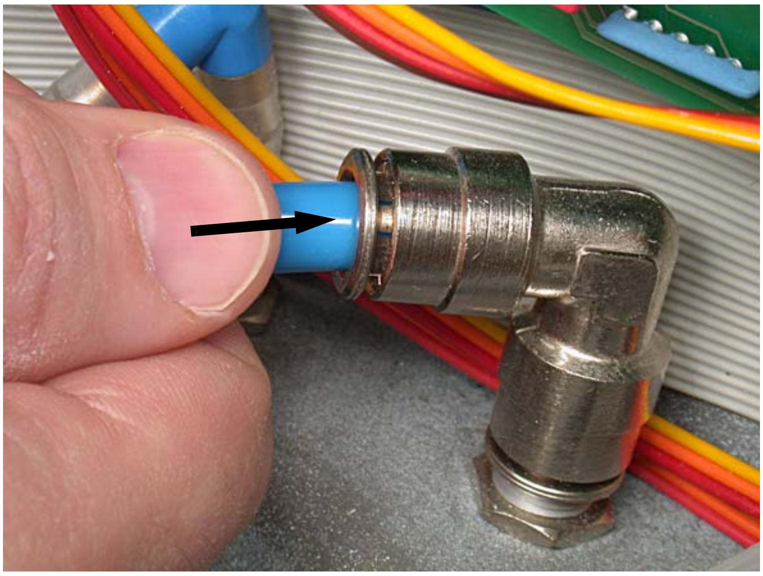


Figure 11-179. Pushing the blue tube into place on the nebulizer connector on the front panel

Testing

WARNING

You must perform all the following tests.

After fitting a new nebulizer compressor, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
    - Section 9, *Running Original or Upgrade 1 test software*
    - Section 10, *Running Upgrade 2 test software*

11.27 Oxygen cell and cell holder

WARNING

Do not dispose of oxygen cells in fire.

11.27.1 References

- Position in gas flow: Section 2.6, *Components monitoring oxygen concentration*, on page 2-18
- Testing and calibrating:
  - TSW 9.4, *Performing the oxygen cell calibration*, on page 9-41.
  - TSW 9.5, *Performing the oxygen cell calibration checks*, on page 9-42.

  Or:
  - Unit 9.4, *Performing the oxygen cell calibration*, on page 10-51.
  - Unit 9.5, *Performing the oxygen cell calibration checks*, on page 10-52.
- Part numbers:
  - Oxygen cell holder: PN 157272, shown in Appendix H.19, *Miscellaneous*, on page H-23.
  - MSA oxygen cell: PN 396008, shown in Appendix H.19, *Miscellaneous*, on page H-26.
  - Teledyne oxygen cell: PN 396009, shown in Appendix H.19, *Miscellaneous*, on page H-26.

11.27.2 Placement

Note

As detailed in Section 11.27.4, GALILEO can use two types of oxygen cell. However, because the two types are almost identical, all comments in this section apply to both cells, unless otherwise stated.

The oxygen cell is mounted in the oxygen cell holder, which is screwed onto the bottom of the chassis, in front of the tank, as shown in Figure 11-180 and Figure 11-181 on page 11-162, and Section 2.6, *Components monitoring oxygen concentration*, on page 2-18.

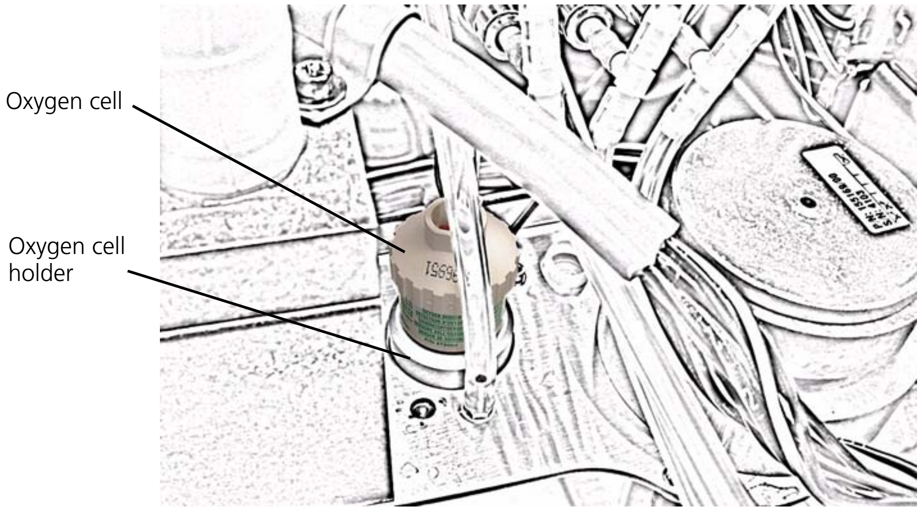


Figure 11-180. **Position of the oxygen cell inside the front enclosure**

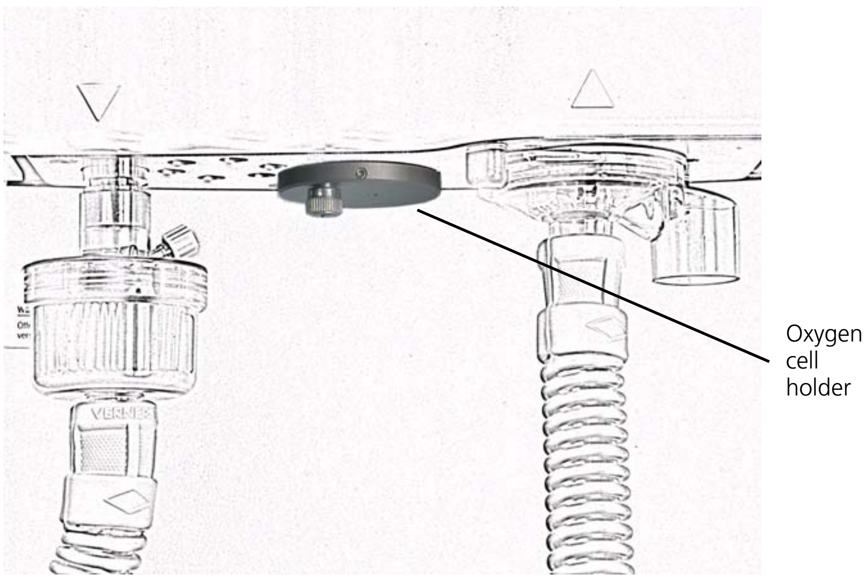


Figure 11-181. **Position of the oxygen cell holder outside GALILEO**

11.27.3 Purpose

Oxygen cell

The purpose of the oxygen cell is to enable the user to monitor the percentage of oxygen in the gases GALILEO delivers to the patient.

However, because GALILEO does not use the cell to control the mixing of gases by the *mixer valves*, it can function perfectly without the cell. For this reason, users can disable the oxygen cell if required, as described in the GALILEO operators' guide, and monitor the oxygen content of the gas delivered to the patient using an external device.

WARNING

GALILEO must never be used for ventilating a patient without some means of monitoring the oxygen content in the gas mixture delivered to the patient.

Oxygen cell holder

The purpose of the oxygen cell holder is to:

- Secure the oxygen cell in position in GALILEO
- Make a gas-tight connection to the oxygen cell solenoid valves (see Section 11.28, *Oxygen cell solenoid valves*, on page 11-168)
- Provide a clear exhaust route for the gases directed to the oxygen cell

11.27.4 Description and function

Oxygen cell

The oxygen cell measures the partial pressure of oxygen in the gas in the tank, and therefore the gas supplied from the tank to the patient circuit (including the nebulizer, where fitted).

Because the oxygen cell is not positioned in the tank, it must be continuously supplied with a flow of gas from the tank. This is documented in Section 2.6, *Components monitoring oxygen concentration*, on page 2-18. Because this flow is very small (and therefore produces almost no pressure), and because the oxygen cell is open to the room air, measurement takes place at ambient pressure.

There are two oxygen cells available for GALILEO, produced by the following manufacturers:

- MSA (Catalyst Research) PN 396008. (Figure 11-183 on page 11-165.)
- Teledyne (Sensor Technologies) PN 396009. (Figure 11-184 on page 11-166.)

Both units are Galvanic fuel cells, and produce a voltage of around 10 mV (depending on the oxygen concentration) in response to a chemical reaction with oxygen.

Each unit comprises a teflon-bonded gold cathode and a lead anode, both of which are submerged in a liquid electrolyte solution. All components are encased in a durable, high density, polyethylene cylinder. When oxygen diffuses through the flouropolymer membrane, the electrochemical reduction of oxygen on the cathode and the corresponding oxidation of the anode generate an electrical current that is proportional to the partial pressure of the oxygen.

Oxygen cell holder

The oxygen cell holder is a simple machined piece, and is shown in detail in Figure 11-182 on page 11-164.

As can be seen, the holder has an O-ring seal at the gas inlet, and two gas outlets to be sure that it can function perfectly, even if one outlet is accidentally blocked by a user.

11.27.5 Further information

Considerations for use

The oxygen cell and holder are reliable devices, but if misused can fail to function properly. Make sure that you and the hospital staff you support are aware of the information in the following warning.

Figure 11-182. Details of the oxygen cell holder

WARNING

- **To function properly, the oxygen cell holder must have its O-ring present, and must be fully tightened into place.**
- **The gas exhausts in the oxygen cell holder must not be blocked.**
- **If GALILEO cannot calibrate an oxygen cell, you must replace the cell with a new one.**
- **An oxygen cell must not be used immediately it is taken from cold storage. It must first be allowed to come up to ambient temperature to prevent condensation forming.**

Working life

Because of the build-up of lead at the anode, both types of cell supplied by HAMILTON MEDICAL AG have a limited working life and must be replaced when GALILEO can no longer calibrate them. Typically, this is about a year (although lifespan depends on the oxygen concentration at which they are used: the higher the concentration, the shorter the working life).

Table 11-14, which displays manufacturers' figures, compares the cells:

Feature	MSA	Teledyne
Measurement range	0 to 100% O_2	0 to 100% O_2
Operating temperature	-5° C to 50° C	0° C to 50° C

Table 11-14. Oxygen cell characteristics

Storage life

At HAMILTON MEDICAL AG, we have found that the storage life of all cells depends largely on temperature. When kept refrigerated, storage life increases significantly.

Warranty period

The oxygen cell is a disposable item, and as such does not have a warranty. However, an active lifetime of at least 1 year, beginning at the date marked on the cell, can be anticipated. This date is embossed in the rim of the MSA cell, as shown in Figure 11-183.

Figure 11-183. Date stamp on the MSA oxygen cell PN 396008

It is printed on the Teledyne cell, as shown in Figure 11-184:

Figure 11-184. **Date stamp on the Teledyne oxygen cell PN 396009**

The following code is used for the date stamp on each kind of oxygen cell:

Letter	Month	Number	Year
A	January	1	2001
B	February	2	2002
C	March	3	2003
D	April	4	2004
E	May	5	2005
F	June	6	2006
G	July	7	2007
H	August	8	2008
I	September	9	2009
J	October		
K	November		
L	December		

Table 11-15. **Code for date stamp on oxygen cell**

Oxygen cell calibration

For information about how GALILEO calibrates the oxygen cell, see Section 11.28, *Oxygen cell solenoid valves*, on page 11-168.

11.27.6 Replacing the oxygen cell

The replacement of the oxygen cell is normally performed by hospital medical staff. This is a simple task, performed according to the maintenance schedule (Section 6, *Engineer preventive maintenance*) or when GALILEO cannot calibrate the cell.

If you must replace the oxygen cell, make a note in the GALILEO test report. You can photocopy one of the following reports from the back of this manual:

- *GALILEO Original and Upgrade 1 Test Report*
- *GALILEO Upgrade 2 Test Report*

11.28 Oxygen cell solenoid valves

CAUTION

Do not attempt to repair the oxygen cell solenoid valves. HAMILTON MEDICAL AG does not permit anyone to make any repairs in the field at a level lower than the smallest parts provided in Appendix H, *Spare parts*.

11.28.1 References

- Position in gas flow: Section 2.6, *Components monitoring oxygen concentration*, on page 2-18.
- Testing and calibrating:
  - *TSW 9: O2 Measurement*, on page 9-40.

  Or:
  - *9: O2 cell calibration & check*, on page 10-50.
- Part number: PN 394034, shown in Appendix H.10, *Valves and assembly groups*, on page H-10.

11.28.2 Placement

The oxygen cell solenoid valves are mounted on the frame, directory above the *mixer*, inside the rear enclosure, as shown in Figure 11-185 below, and Figure 2-5, *Components monitoring oxygen concentration*, on page 2-18.

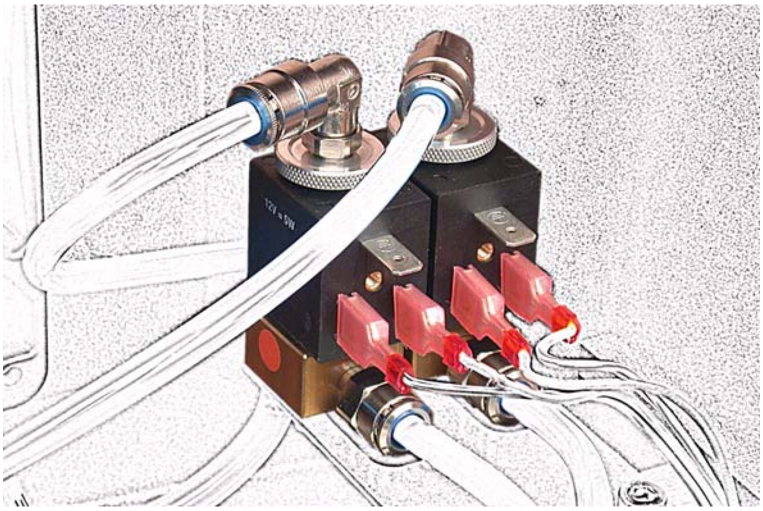


Figure 11-185. The position of the oxygen cell solenoid valves

11.28.3 Purpose

The purpose of the oxygen cell solenoid valves is to:

- Enable the oxygen cell to monitor the gas mixture in the tank. The valves do this by directing gas from the tank to the *oxygen cell*.
- Enable oxygen cell calibration. The valves do this by directing oxygen and air from the gas inlets to the oxygen cell.

For information about gas-flows through the oxygen cell solenoid valves in the context of the complete pneumatic system, see Section 2.6, *Components monitoring oxygen concentration*, on page 2-18.

11.28.4 Description and function

By coordinated switching, the two oxygen cell solenoid valves control three gas-flows (air, oxygen, and tank mixture) to the oxygen cell. (Figure 11-186 and Figure 11-187.)

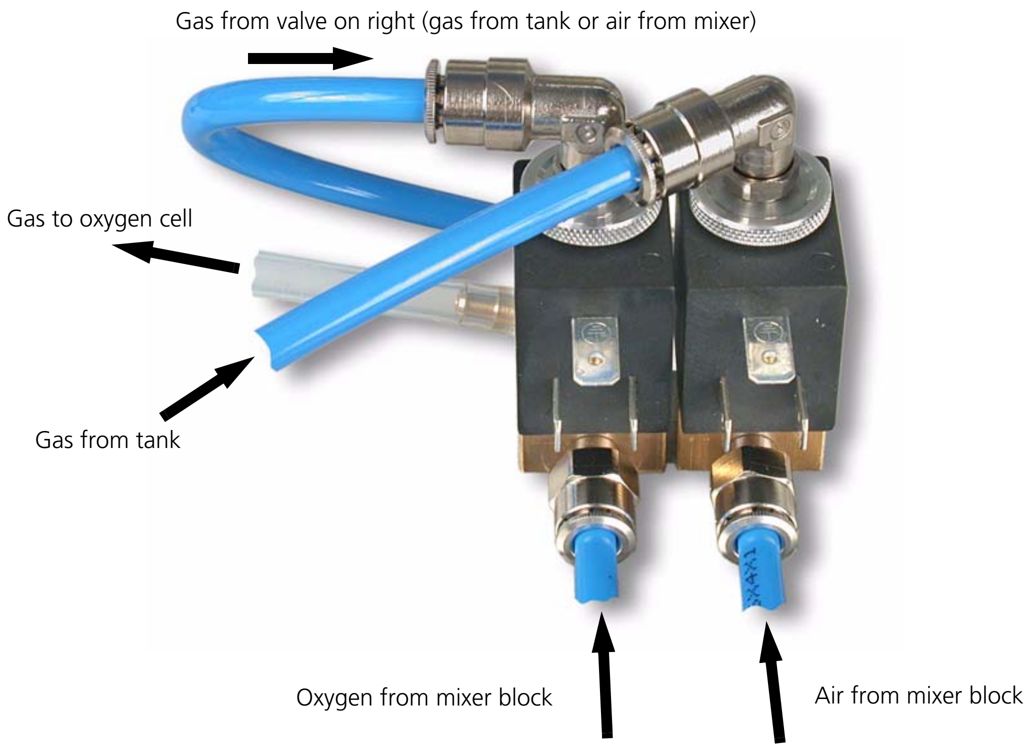


Figure 11-186. Gas-flows to and from oxygen cell solenoid valves, front view

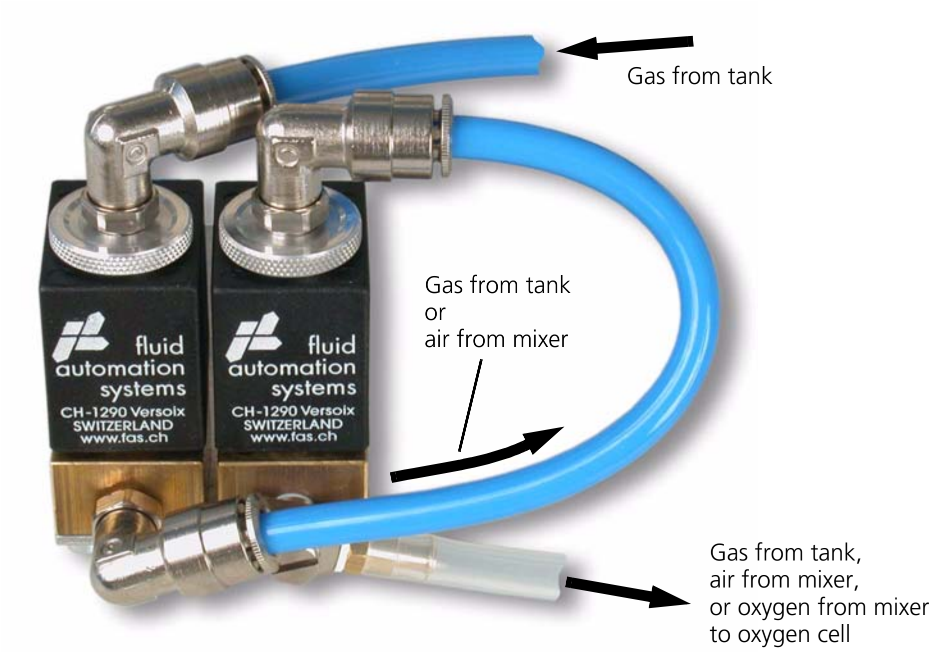


Figure 11-187. Gas-flows to and from oxygen cell solenoid valves, rear view

Each valve has two inputs and one output. The inputs to the valve on the right in Figure 11-186 are: gas from the tank, and air from the mixer. This valve can therefore switch tank gas or air to the valve on the left.

The valve on the left in Figure 11-186 also has two inputs: the output from the first valve, or oxygen from the mixer.

By working in combination, the two valves can therefore direct one of three gas-flows — tank gas, air, or oxygen — to the oxygen cell.

11.28.5 Further information

Oxygen cell valve characteristics

You cannot repair the oxygen cell solenoid valves: you must replace them if faulty.

The valves are not electronically sensitive. However, they can be damaged by water or dirt entering either of the gas inlets.

Oxygen cell calibration

As mentioned in Section 11.28.3, *Purpose*, one of the functions of the oxygen cell solenoid valves is oxygen cell calibration.

The expression “oxygen cell calibration” must be correctly understood: during this procedure, the characteristics of the oxygen cell are not changed or adjusted in any way. Instead, GALILEO discovers the characteristics of the oxygen cell, and then calibrates its own logic accordingly, so that it can properly interpret signals from the cell.

Oxygen cell calibration can be initiated in two ways:

- By the medical user. This is done by selecting and activating **`O2 Cell`** in the **`Calibration`** menu.
- By the engineer. This is done in *TSW 9: O2 Measurement*, on page 9-40, or *9: O2 cell calibration & check*, on page 10-50.

The oxygen cell calibration takes place with the cell exposed to 100% oxygen. The linearity of the cell output is then tested at 50% oxygen, 21% oxygen (pure air) and 100% oxygen. Although initiated by the user, the calibration procedure is performed completely automatically by GALILEO.

During calibration, GALILEO uses the oxygen cell solenoid valves to direct gases containing the required percentage of oxygen to the oxygen cell. These gases are:

- Oxygen from the external supply.
- Air from the external supply.

11.28.6 Replacing the oxygen cell solenoid valves

Removing the old valve

CAUTION

Replacement of the oxygen cell solenoid valves is an easy procedure, but must be performed correctly. In particular, the brass base of each valve must be correctly positioned on the mounting plate. For more information, see Figure 11-194 on page 11-175.

1. Open GALILEO’s main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
2. Locate the oxygen cell solenoid valves. (Section 11.28.2, on page 11-168.)
3. Note the colors of the cables. (Figure 11-188)

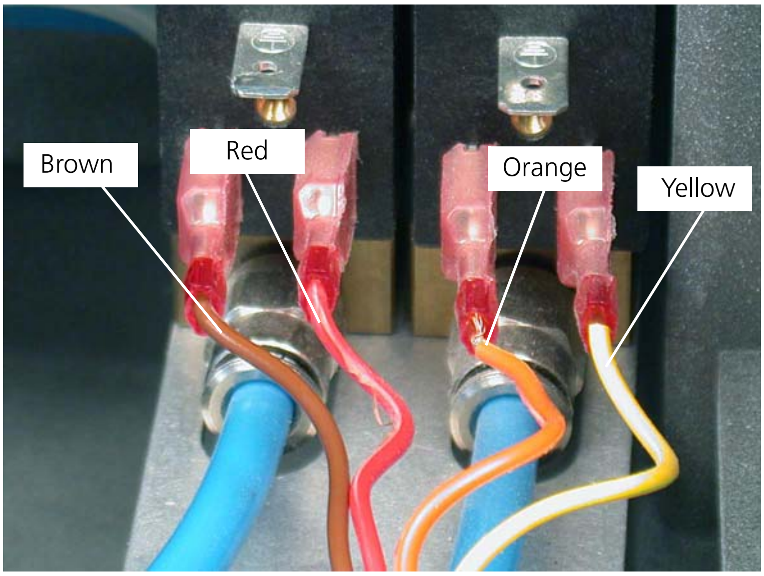


Figure 11-188. Noting the colors of the cables

4. Disconnect the cables from the valves. (Figure 11-189.)

CAUTION

Pull the connectors, not the cables.

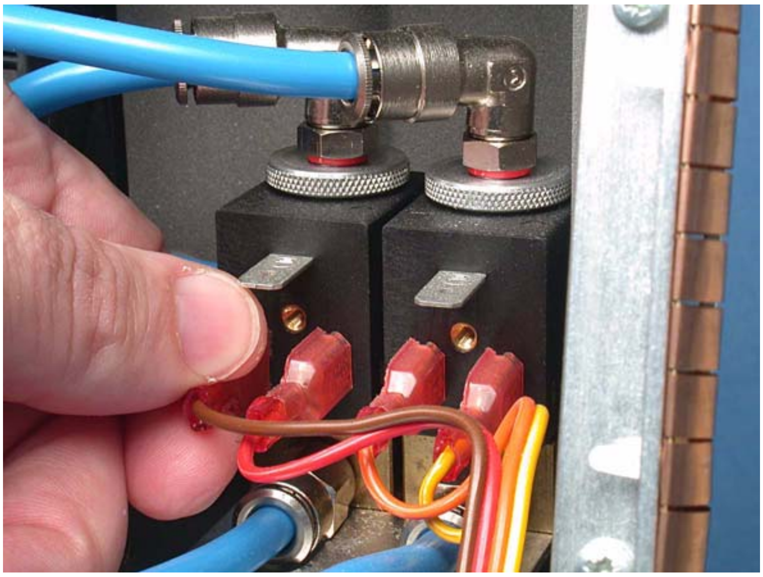


Figure 11-189. Removing the electrical connections

5. Remove from the mixer block, the two blue tubes that connect to the oxygen cell solenoid valves. To do this, push down on the inner collar of the connector with a suitable spanner, while pulling up the blue tubing. (Figure 11-190.)

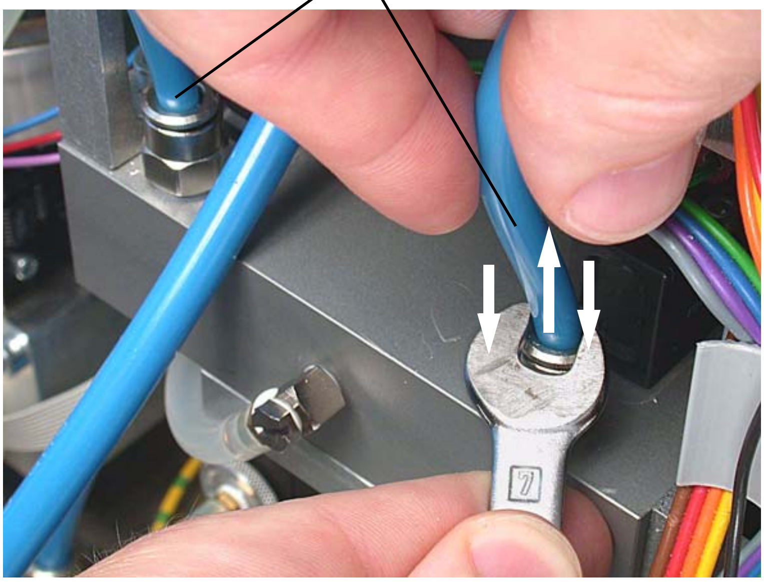


Figure 11-190. Removing one of the oxygen cell solenoid valve connections

6. In the same way, remove from the right-hand valve, the blue tube connecting to the tank. (Figure 11-191.)

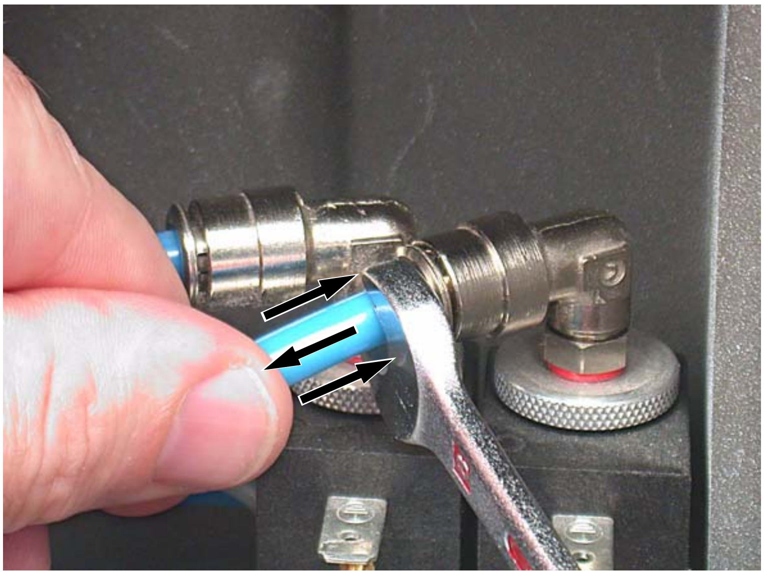


Figure 11-191. Removing the blue tube connecting to the tank

7. Pull off from the left-hand valve, the clear tube that connects to the oxygen cell. (Figure 11-192.)

Figure 11-192. Pulling off the clear tube to the oxygen cell

8. Remove the two hexagonal-drive (Allen) screws that secure the mounting plate.

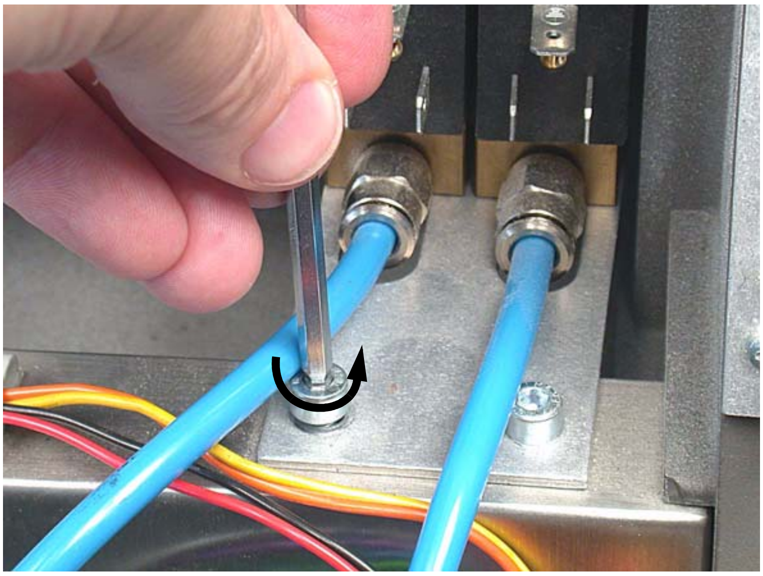


Figure 11-193. Removing the mounting plate

Fitting the new valves

Replace one or both of the valves as required. This procedure is simple, and is not shown in detail here. Notice, however, the two following cautions:

CAUTION

- Be sure that both connectors to the mixer are mounted in the threaded hole marked **2** on the brass block. (Figure 11-194.)
- Make sure that all fittings, especially the one on the top of the valve, are tightened sufficiently to be gas-tight.

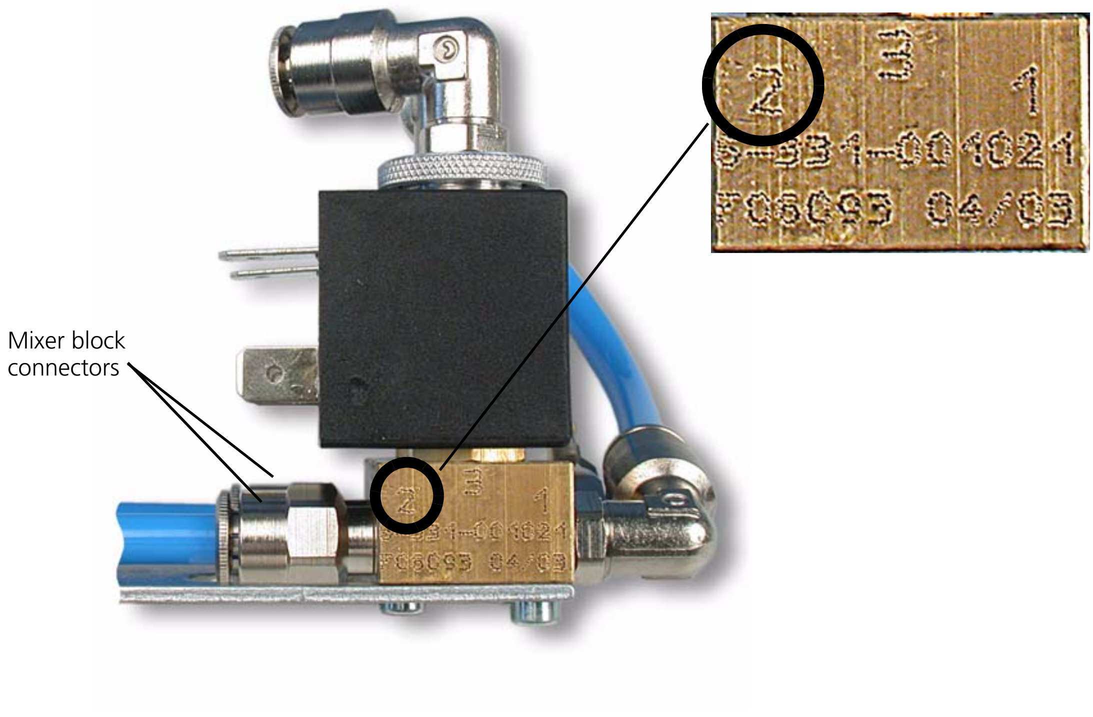


Figure 11-194. The correct position for the mixer block connectors

Continue by fitting the valves into GALILEO. This is basically a reversal of the removal procedure. Notice, however, that to fit the blue tubes, you simply push them into their housings—there is no need to use a spanner.

Testing

WARNING

You must perform all the following tests.

After fitting one or both new oxygen cell solenoid valves, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
  - Section 9, *Running Original or Upgrade 1 test software*
  - Section 10, *Running Upgrade 2 test software*

11.29 Power supply and fuses

CAUTION

Do not attempt to repair the power supply. HAMILTON MEDICAL AG does not permit anyone to make any repairs in the field at a level lower than the smallest parts provided in Appendix H, *Spare parts*.

11.29.1 References

- Position in enclosure: Section 3.4, *Components in the column*, on page 3-12.
- Testing: Section 7.3, *Checking voltages*, on page 7-3.
- Part numbers:
  - Fuses: PN 363071, PN 363078, shown in Appendix H.14, *O-rings and fuses*, on page H-15.
  - Power supply for GALILEOs with backup batteries: PN 155352, shown in Appendix H.7, *Boards*, on page H-5.
  - Power supply for GALILEOs without backup batteries: PN 396136, shown in Appendix H.7, *Boards*, on page H-7.

11.29.2 Placement

The power supply and backup battery fuse are in GALILEO's column, as shown in Figure 11-195 below, and in and Figure 3-3, *Components in the column*, on page 3-12.

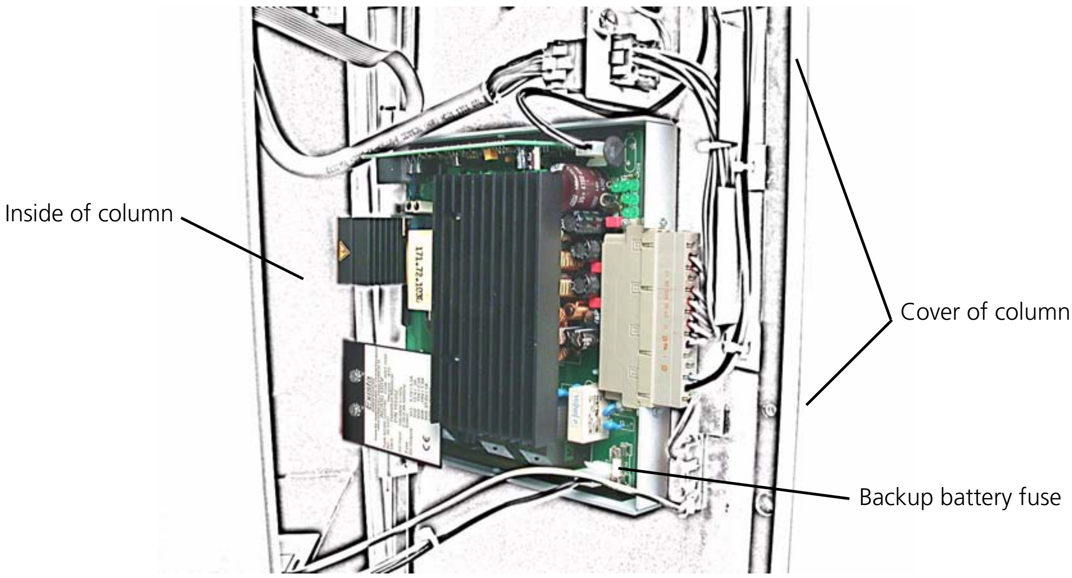


Figure 11-195. Position of the power supply in the opened column

The two mains supply fuses are built into the mains connector, as shown in Figure 11-198 on page 11-179.

11.29.3 Purpose

Power supply

The purpose of GALILEO's power supply is to convert the external ac power supply to the range of dc voltages that GALILEO requires.

Fuses

The purpose of all fuses is to protect GALILEO against damage in event of a short circuit in the internal power supply.

11.29.4 Description and function

Power supply

The power supply is of a modern switched design, with the following characteristics:

Feature	Specification
Input voltage	90 V ac to 260 V ac
Input frequency	50 Hz to 60 Hz
Output voltages	+5 V dc
	+12 V dc
	+15 V dc
	-15 V dc

Table 11-16. Power supply specifications

Fuses

The reason for two mains power supply fuses is to protect each side of the mains circuit.

Note
The battery backup fuse is not supplied by HAMILTON MEDICAL AG, and is not shown in the parts list. If the fuse fails, you must replace the complete power supply board. (Section 11.29.8, *Replacing the power supply*, on page 11-179.)

For the specifications of the mains power fuses, see Appendix H.14, *O-rings and fuses*, on page H-15.

11.29.5 Further information

For information about troubleshooting using the power supply board, see Section 12.3.2, *Power supply board LED troubleshooting*, on page 12-62.

11.29.6 Replacing a mains power supply fuse

Replacing a fuse is a simple procedure. However, a blown fuse can indicate an internal failure. After replacing a mains fuse, be sure to perform the tests shown in *Testing* on page 11-182.

WARNING

When replacing a fuse, use a new fuse of the correct type. (Appendix H.14, *O-rings and fuses*, on page H-15.)

1. Disconnect the power supply cord from the rear panel. (Figure 11-196.)

Figure 11-196. Disconnecting the power supply cord

2. Pull the fuse chamber towards you.

Figure 11-197. Opening the fuse chamber

3. Push the fuse up with a screwdriver to remove it.

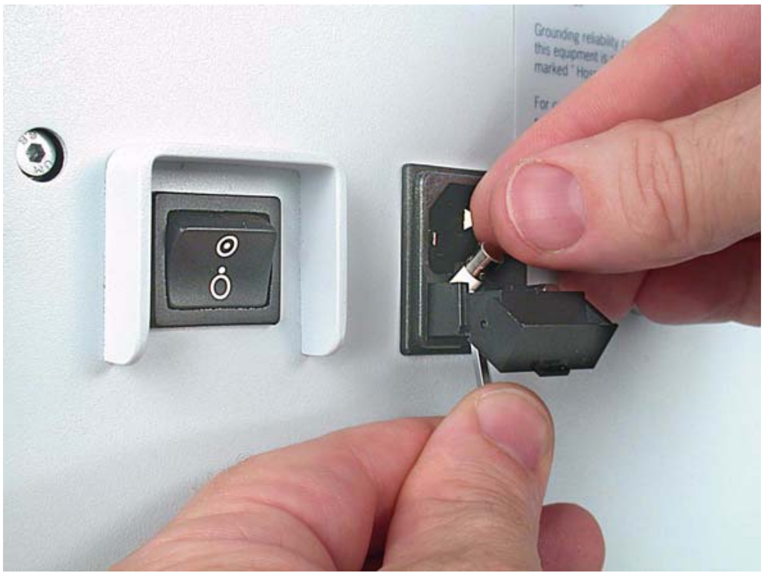


Figure 11-198. Removing a mains power supply fuse

4. Replace the fuse by reversing the procedure.
5. Attach GALILEO to the power supply and switch it on.
   If the fuse blows again:
   - Search for damaged wiring inside the column.
   - Replace the power supply.
6. Perform the tests in *Testing* on page 11-182.

11.29.7 Responding to a blown backup battery fuse

If the backup battery fuse blows, you must replace the complete power supply. (Section 11.29.8, *Replacing the power supply*.)

CAUTION

Do not attempt to replace the fuse alone.

11.29.8 Replacing the power supply

Note

If you must replace the power supply of a GALILEO without battery backup (power supply PN 396136), order one of the following components (each of which includes new power supply PN 155352):

- PN 155450 Standard trolley
- PN 155451 Short trolley
- PN 155515 Shelf mount

11.29.8.1 Removing the old power supply

1. Open GALILEO's column, as described in Section 11.5, *Opening the column*, on page 11-6.
2. Remove from the power supply board all cables connecting it to GALILEO. (Figure 11-199.)

Note
To remove the main power connector, you must compress it hard between finger and thumb at the points shown in Figure 11-200.

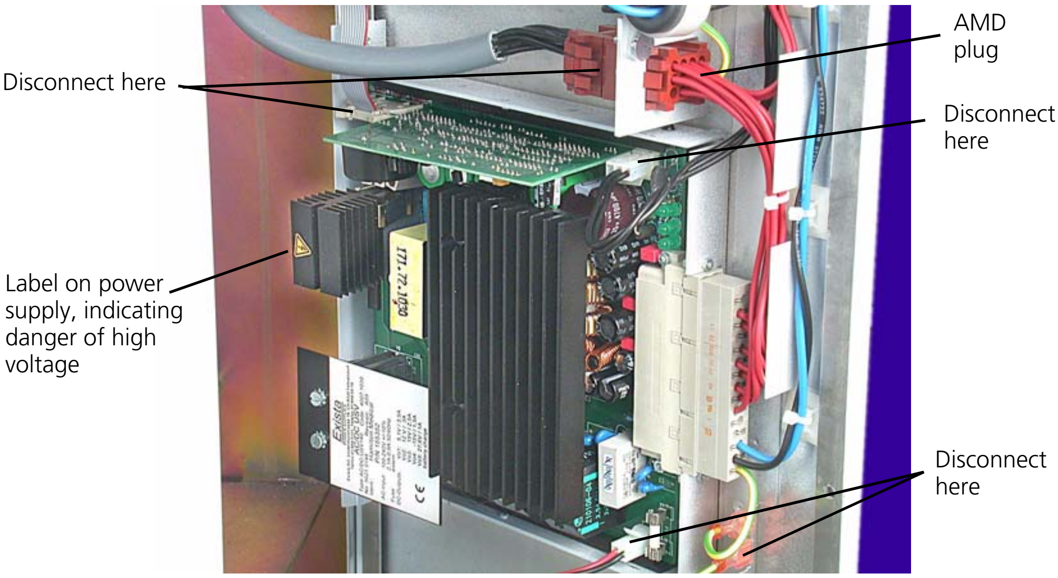


Figure 11-199. Cable connections you must remove

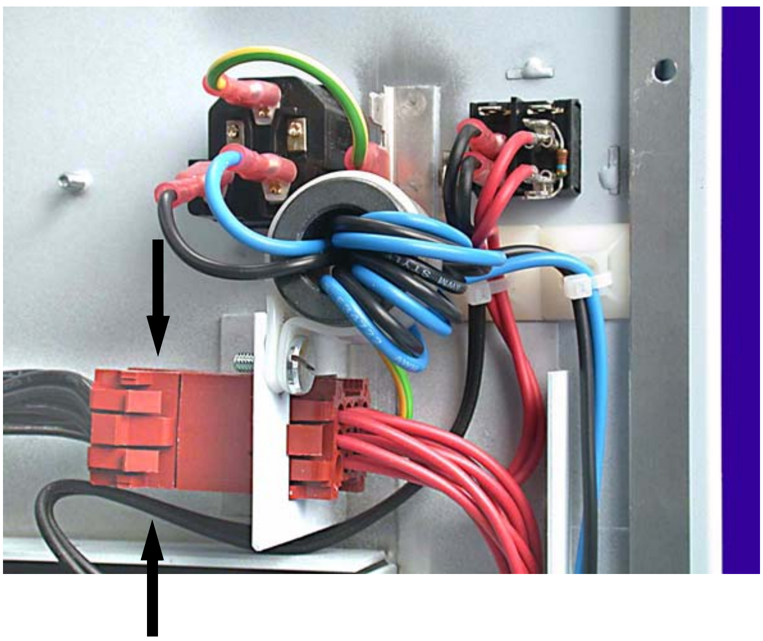


Figure 11-200. Pressure points on the main power supply cable

3. Remove the rear cover, and place it on a suitable surface.
4. Unscrew the retaining strip securing the power supply in its housing. (Figure 11-201.)

Figure 11-201. Unscrewing the power supply

5. Slide the power supply out from its housing. (Figure 11-202.)

Figure 11-202. Sliding the power supply from its housing

11.29.8.2 Fitting the new power supply

Fitting the new power supply is basically a reversal of the removal procedure.

Notice that newer power supplies are fitted with a security clamp. (Figure 11-203 and Figure 11-204.)

Figure 11-203. Power supply PN 155352 with security clamp PN 155542

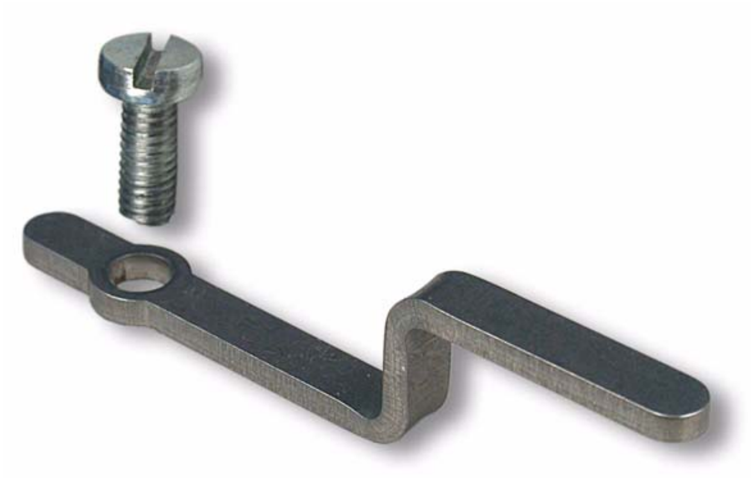


Figure 11-204. Security clamp PN 155542 and original screw

Testing

WARNING

You must perform all the following tests.

1. Perform the internal voltage test outlined in step (2) on page 7-5 of Section 7.3, *Checking voltages*. This test ensures that the correct voltages are present on the printed circuit boards inside GALILEO.

   If this test is not successful, it is likely that there is a loose connection somewhere between the internal power supply and the printed circuit boards. Rectify this.

2. When the above test is successful, continue with the tests in the following sections:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
    - Section 9, *Running Original or Upgrade 1 test software*
    - Section 10, *Running Upgrade 2 test software*

11.30 Press-and-turn knobs (P&T-knobs) and encoders

CAUTION

Do not attempt to repair the encoders. HAMILTON MEDICAL AG does not permit anyone to make any repairs in the field at a level lower than the smallest parts provided in Appendix H, *Spare parts*.

11.30.1 References

- Position in enclosure: Section 3.2, *Components in the front enclosure*, on page 3-2.
- Testing:
  - TSW 4.3, *Performing the monitoring knob and control knob checks*, on page 9-16.

  Or:
  - Unit 4.3, *Performing the monitoring knob and control knob checks*, on page 10-19.
- Part numbers:
  - P&T-knob outer, new aluminium type: PN 155704, shown in Appendix H.19, *Miscellaneous*, on page H-23.
  - P&T-knob inner: PN 155705, shown in Appendix H.19, *Miscellaneous*, on page H-23.
  - P&T-knob inner, complete with old-style plastic outer: PN 155201, shown in Appendix H.19, *Miscellaneous*, on page H-21.
  - Encoders: PN 372032, shown in Appendix H.19, *Miscellaneous*, on page H-26.

11.30.2 Placement

The press-and-turn knobs are positioned on GALILEO's front panel, as shown in Figure 11-205 below, and in Figure 3-1, *Components in the front enclosure*, on page 3-2.

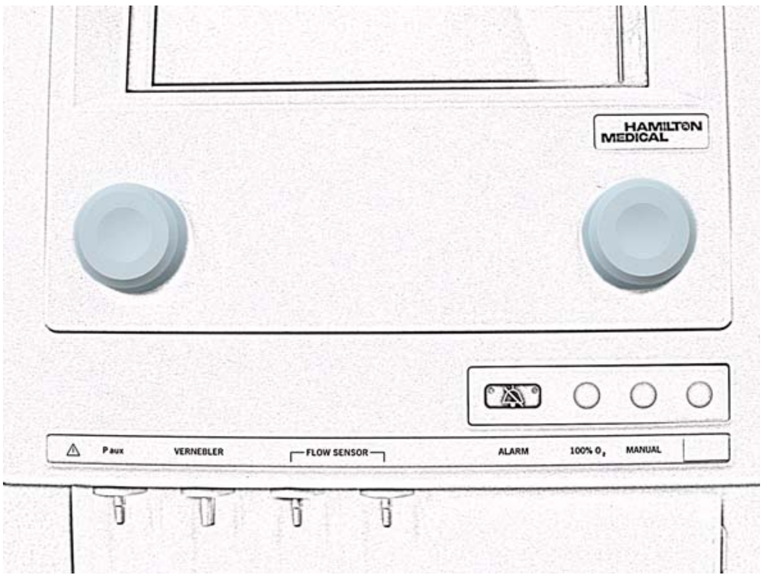


Figure 11-205. **The position of the P&T-knobs**

The original knobs were grey plastic, as shown in Figure 11-205. However, since mid-year 2004, new solid aluminium knobs have been used. (Figure 11-206.)

Figure 11-206. New aluminium knob

Both types of knobs use the same, identical inner. (Figure 11-207.)

Figure 11-207. Knob inner, for both new aluminium and old plastic knobs

The complex switches behind the knobs — the encoders — are not visible unless GALILEO is dismantled, but can be seen in Figure 3-1, *Components in the front enclosure*, on page 3-2, and in Figure 11-208.

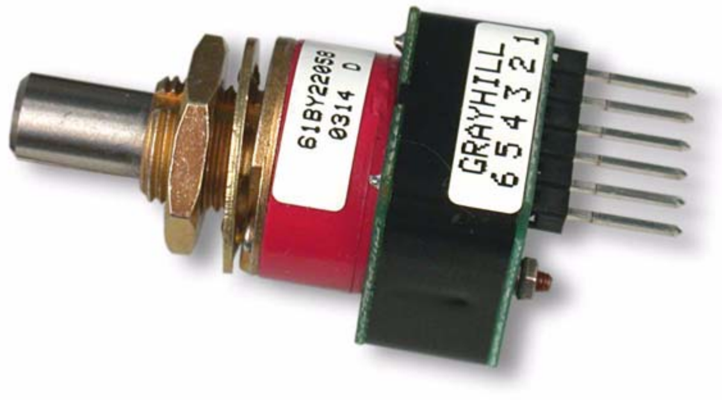


Figure 11-208. An encoder

The encoders translate the movements of the P&T-knobs (the pushes and turns that the user makes) into electrical signals that GALILEO can use.

11.30.3 Purpose

The purpose of the P&T-knobs is to enable medical users and engineers to interact with GALILEO.

For more information about medical use, see the appropriate GALILEO operators' manual.

For more information about use by engineers, see Section 9.5, *Entering test software mode*, on page 9-2, or Section 10.5, *Entering test software mode*, on page 10-2.

11.30.4 Description and function

As in Section 11.30.3, *Purpose*.

11.30.5 Replacing a P&T-knob

It is unlikely that you must replace a P&T-knob, except in cases where physical damage has taken place. Replacement is identical for both old-model (PN 155201) and new-model (PN xx) knobs.

Removing an old knob

1. Take a firm grip of the outer knob, and pull it free. Figure 11-209 shows removal of the older style, plastic knob.

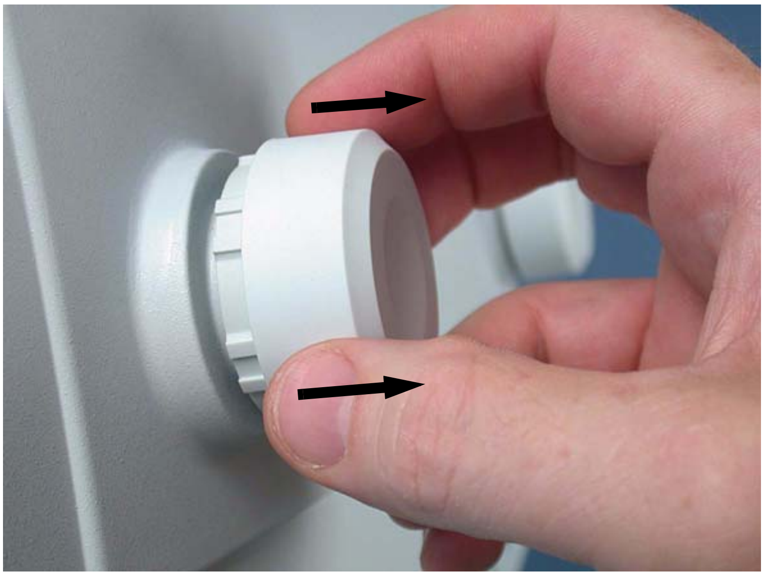


Figure 11-209. Removing the outer knob

2. Unscrew the nut securing the inner knob using a 10 mm spanner (wrench), and pull the knob free. (Figure 11-210 and Figure 11-211.)

Figure 11-210. Unscrewing the inner knob

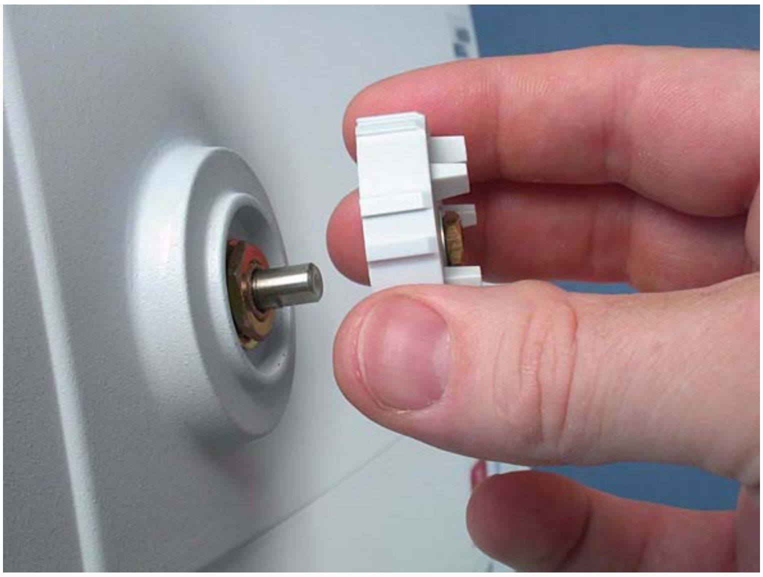


Figure 11-211. **Pulling the inner knob free**

Fitting a new knob

Fitting a new knob is essentially a reversal of the removal procedure.

Note
However, you must position the knob so that it is free to move when pressed. To do this, position the P&T-knob so there is a gap of exactly 3 mm between it and GALILEO’s front enclosure.
(Figure 11-212.)

Figure 11-212. **Positioning the P&T-knob**

The gap is to make sure that when a user presses the knob, the encoder registers the press before the knob hits the front enclosure.

Testing

After fitting a new knob, switch on GALILEO and make sure that it responds to pushes from the knob. (If it does not, refit the knob, making sure that to leave enough room for the knob to move.)

While it is not necessary to run test software after replacing a knob, be suspicious if the reason for the replacement was physical damage. If in any doubt, perform:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
    - Section 9, *Running Original or Upgrade 1 test software*
    - Section 10, *Running Upgrade 2 test software*

11.30.6 Replacing an encoder

Removing an old encoder

1. Remove the connector board, as described in *Removing the connector board* on page 11-40.
   This reveals the two encoders inside the front enclosure. (Figure 11-213.)

Figure 11-213. **One of the two encoders inside GALILEO's front enclosure**

2. Remove the P&T-knob of the encoder you must replace, as described in *Removing an old knob* on page 11-187.

3. Unscrew and remove the encoder. (Figure 11-214.)

Figure 11-214. Unscrewing the encoder

Fitting a new encoder

To fit a new encoder, simply reverse the removal procedure. However, be sure to read:

- *Fitting a new knob* on page 11-188.
- *Fitting the new connector board* on page 11-41.

Note also that the encoders must be positioned with their electrical contacts inward, as shown in Figure 11-215, so that they mate with the cut-outs in the connector board.

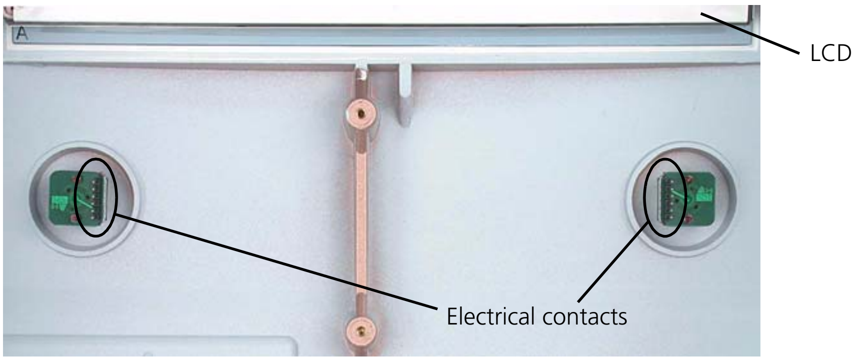


Figure 11-215. Correct positions of encoders

Testing

WARNING

You must perform all the following tests.

After fitting a new encoder, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
    - Section 9, *Running Original or Upgrade 1 test software*
    - Section 10, *Running Upgrade 2 test software*

11.31 Sensor board

CAUTION

Do not attempt to repair the sensor board. HAMILTON MEDICAL AG does not permit anyone to make board-level repairs to GALILEO in the field. If a board is faulty, you must replace it with References

- Position in gas flow and in enclosure:
  - Section 2.3, *Components performing principle pressure and flow measurements*, on page 2-6.
  - Section 2.8, *Components supporting auxiliary pressure measurement*, on page 2-22.
  - Section 3.3, *Components in the rear enclosure*, on page 3-8.
- Testing and calibrating:
  - TSW 8.4, *Performing the dP mixer zero calibration*, on page 9-32.
  - TSW 8.5, *Performing the dP Flow Sensor zero calibration*, on page 9-32
  - TSW 8.7, *Performing the dp Flow Sensor full-scale check*, on page 9-36
  - *TSW 10: Mixer*, on page 9-45
  - TSW 11.4, *Performing the Flow-Sensor autozero-valve check*, on page 9-53

  Or:
  - Unit 8.4, *Performing the dP mixer zero calibration*, on page 10-39.
  - Unit 8.5, *Performing the dP Flow Sensor zero calibration*, on page 10-40.
  - Unit 8.7, *Performing the dP Flow Sensor full-scale check*, on page 10-45.
  - *10: Mixer calibration & checks*, on page 10-55.
  - Unit 11.4, *Performing the Flow-Sensor autozero-valve check*, on page 10-64.
- Part numbers:
  - Sensor board for GALILEOs with old type mixer block PN 155333: PN 155152, shown in Appendix H.7, *Boards*, on page H-5.
  - Sensor board for GALILEOs with new type mixer block PN 155587: PN 155699, shown in Appendix H.7, *Boards*, on page H-6.

11.31.1 Placement

The sensor board is positioned in the rear enclosure as shown in Figure 11-216 below, and in Figure 2-2, *Components performing principle pressure and flow measurements*, on page 2-6.

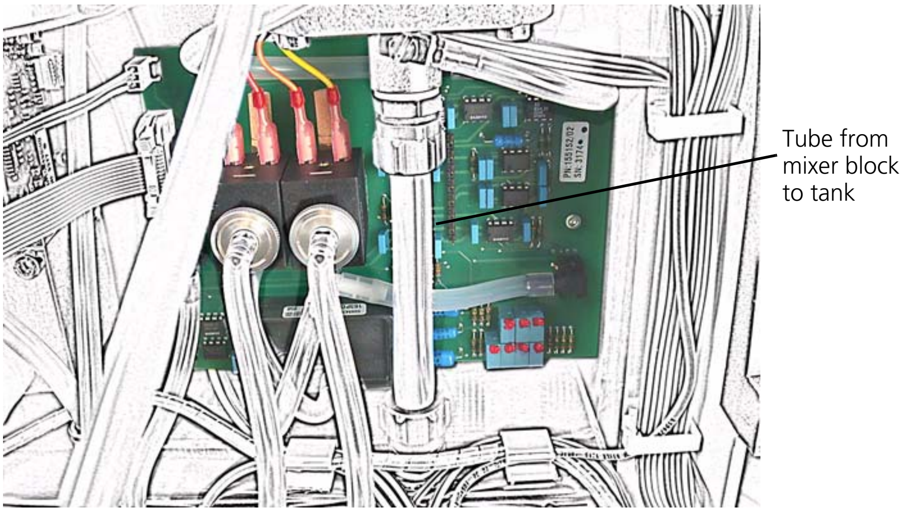


Figure 11-216. Position of the sensor board in the rear enclosure

11.31.2 Purpose

The purpose of the sensor board is to hold:

- Most of the pressure sensors in GALILEO. (The *servo board* holds the *dP servo differential pressure sensor* and the *Ppat pressure sensor*.)
- The potentiometers that you use to adjust the pressure sensors.
- The Flow Sensor autozero valves.

The board has pneumatic connections to the *mixer* block by means of internal tubing, and to the *Flow Sensor* by means of the blue (patient side) and clear (ventilator side) pressure-sensing tubes.

For information about gas-flows to the sensor board in the context of the complete pneumatic system, see Section 2.3, *Components performing principle pressure and flow measurements*, on page 2-6 and the following sections.

11.31.3 Description and function

There are two types of sensor board:

- PN 155152, for GALILEOs with old type mixer block PN 155333
- PN 155699, Sensor board for GALILEOs with new type mixer block PN 155587

However, the boards are almost identical in appearance, and completely identical in function. (Some components have different values.) All comments in the following sections apply to both boards.

The sensor board holds the components shown in Figure 11-217 and Table 11-17.

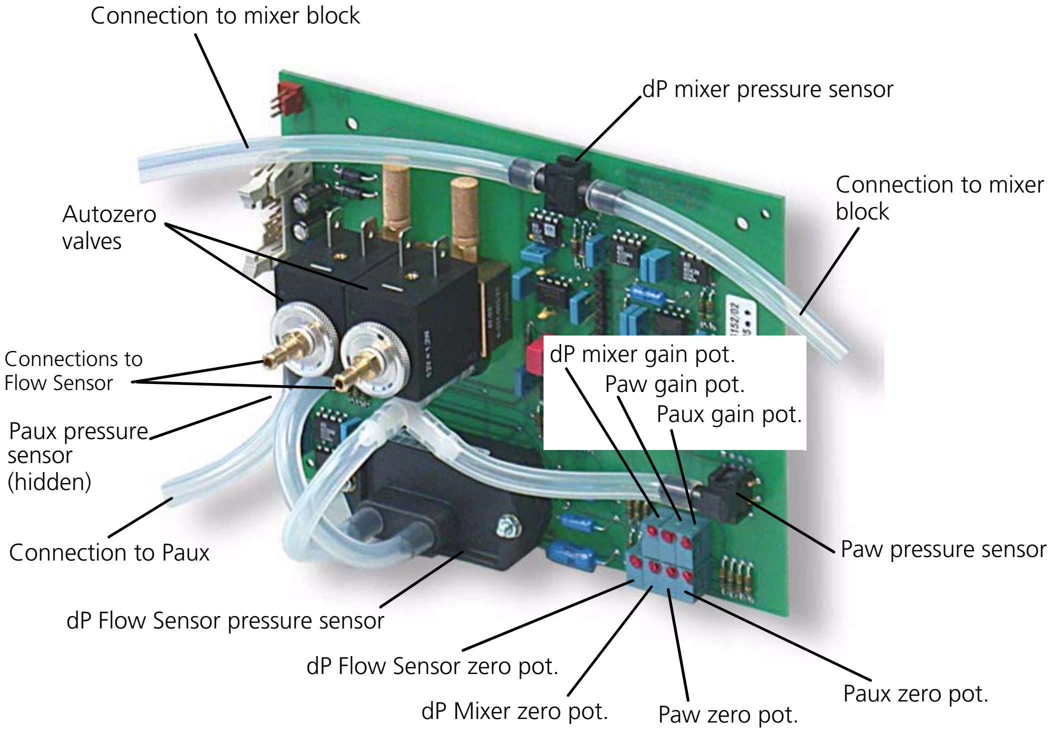


Figure 11-217. Details of the sensor board

Component name	Function
dP mixer differential pressure sensor	Measures the difference in pressure across the sintered disk flow restrictor in the *mixer* block. GALILEO calculates the rate of flow of gas through the block from this measurement. For more information, see Section 11.25, *Mixer block*.
dP Flow Sensor differential pressure sensor	Measures the difference in pressure between the two chambers of the Flow Sensor. GALILEO calculates the rate of flow of gas through the Flow Sensor, to and from the patient, from this measurement.
Paw pressure sensor	Measures the absolute pressure in the chamber of the Flow Sensor that is attached to the blue pressure-sensing tube. (This chamber must always be positioned closest to the patient.)
Paux pressure sensor	Measures the absolute pressure at an external pressure source. The use of this pressure sensor is determined by what equipment (if any) the user attaches to the **Paux** connector on GALILEO's front panel.
Flow Sensor autozero valves	Open regularly to expose the dP Flow Sensor differential pressure sensor to ambient air. This enables GALILEO to calculate an offset value to correct for drift in the dP Flow Sensor pressure sensor. For more information about the autozero procedure, see *Flow Sensor autozeroing* on page 11-81.

Table 11-17. Components on the sensor board

<table>
<tr><th>Component name</th><th colspan="2">Function</th></tr>
<tr><td>dP mixer gain potentiometer</td><td rowspan="3">Enable you to adjust the gain that GALILEO applies to the signals from the dP mixer, Paw and Paux pressure sensors.</td><td rowspan="7">You do this in TSW 8: Zero and Fullscale, on page 9-28 or in 8: Zero and full-scale calibration, on page 10-34.</td></tr>
<tr><td>Paw gain potentiometer</td></tr>
<tr><td>Paux gain potentiometer</td></tr>
<tr><td>dP Flow Sensor zero potentiometer</td><td rowspan="4">Enable you to adjust the zero drift compensation (or offset) that GALILEO applies to the signals from the dP Flow Sensor, dP mixer, Paw and Paux pressure sensors.</td></tr>
<tr><td>dP mixer zero potentiometer</td></tr>
<tr><td>Paw zero potentiometer</td></tr>
<tr><td>Paux zero potentiometer</td></tr>
</table>

Table 11-17. Components on the sensor board

11.31.4 Replacing the sensor board

Removing the old sensor board

1. Open GALILEO’s main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
2. Locate the sensor board. (Section 11.31.1.)
3. Remove from the mixer block, the pneumatic tubing connecting the sensor board to the mixer. (Figure 11-218.).

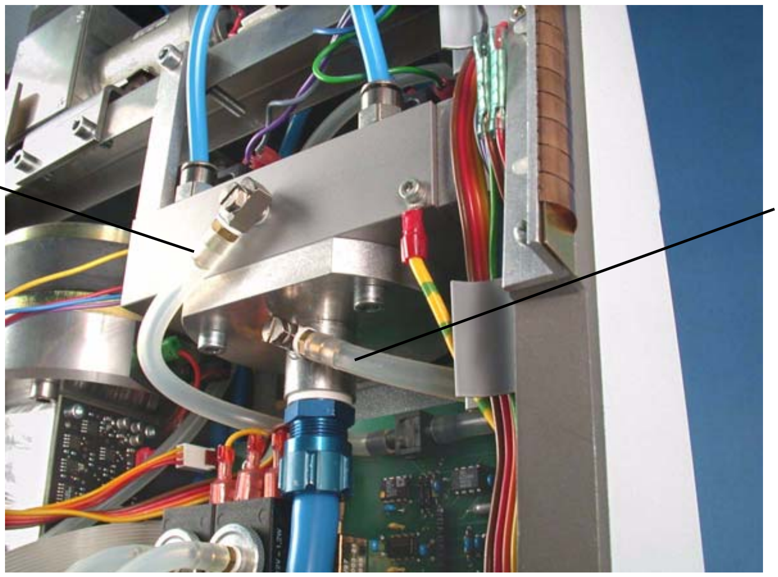


Figure 11-218. The sensor board to mixer block connections

4. Remove from the sensor board, the electrical connections to the servo board and the connector board. (Figure 11-219.)

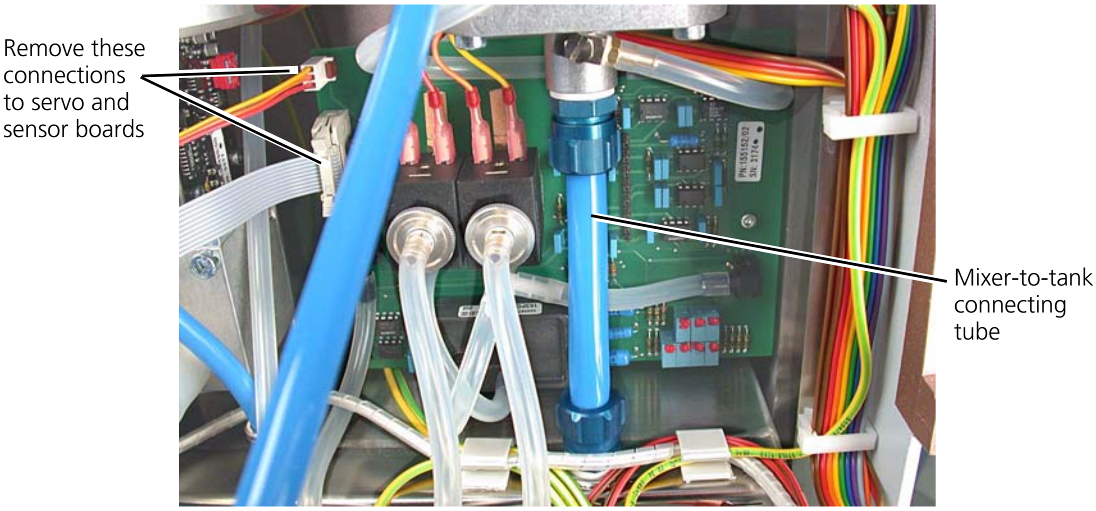


Figure 11-219. Connections to servo board and connector board

5. Remove the four hexagonal-drive (Allen) screws securing the sensor board. This is a little difficult to do, as it is not possible to see the upper right-hand screw. (Figure 11-220.)

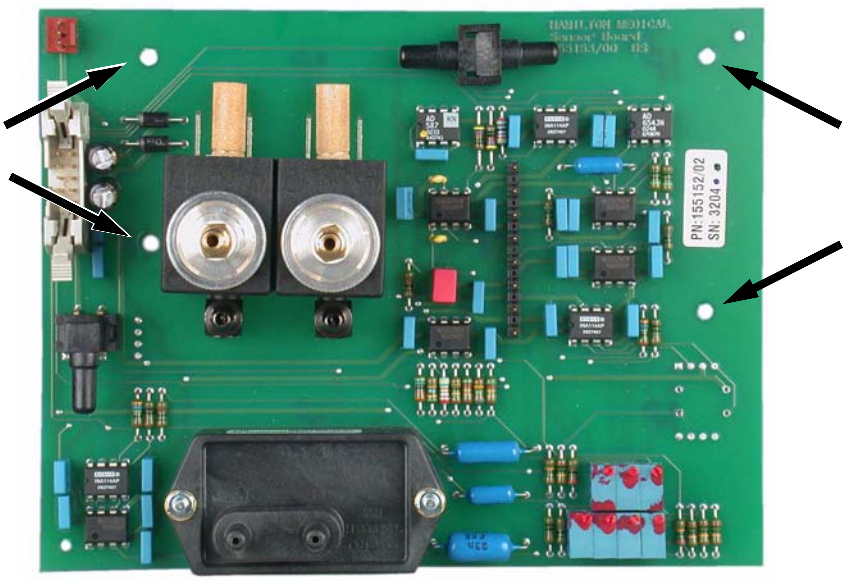


Figure 11-220. Position of screws on sensor board

6. Remove the sensor board, pulling it around the large blue mixer-to-tank connecting tube shown in Figure 11-219.

Note
It is not necessary to remove the mixer/tank connecting tube.

7. Remove all tubing and electrical connections from the servo board.

Fitting the new sensor board

Fitting the new sensor board is simply a reversal of the removal procedure.

Testing

WARNING

You must perform all the following tests.

After fitting a new sensor board, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
    - Section 9, *Running Original or Upgrade 1 test software*
    - Section 10, *Running Upgrade 2 test software*

11.32 Tank and flow restrictors

CAUTION

Do not attempt to repair the tank or the flow restrictors. (Although you are permitted to replace flow restrictors.) HAMILTON MEDICAL AG does not permit anyone to make any repairs in the field at at level lower than the smallest parts provided in Appendix H, *Spare parts*.

11.32.1 References

- Position in gas flow and in enclosure:
  - Flow restrictors to create Flow Sensor rinse flow:
    Section 2.3, *Components performing principle pressure and flow measurements*, on page 2-6.
  - Flow restrictors to control flow of air and oxygen to the oxygen cell:
    Section 2.6, *Components monitoring oxygen concentration*, on page 2-18.
  - Flow restrictor to create rinse flow for optional auxiliary pressure sensor:
    Section 2.8, *Components supporting auxiliary pressure measurement*, on page 2-22.
- Testing:
  - Tank: TSW 10.3, *Performing the tank leakage check*, on page 9-46.
  - Flow restrictors controlling rinse flow: TSW 11.5, *Performing the rinse flow check*, on page 9-54.

  Or:
  - Tank: Unit 10.3, *Performing the tank leakage check*, on page 10-56.
  - Flow restrictors controlling rinse flow: Unit 11.5, *Performing the rinse flow check*, on page 10-66.
- Part numbers:
  - Tank: PN 155176, shown in Appendix H.13, *Enclosures, chassis, column*, on page H-14.
  - Flow restrictors: PN 155264, PN 155265, PN 155266 and PN 155716, shown in Appendix H.19, *Miscellaneous*, on page H-23.

11.32.2 Placement

Tank

The tank (or reservoir) is integrated into GALILEO's chassis. (Figure 11-221.)

Flow restrictors

Each flow restrictor is permanently mounted in a connector, and cannot be seen when the connector is in place.

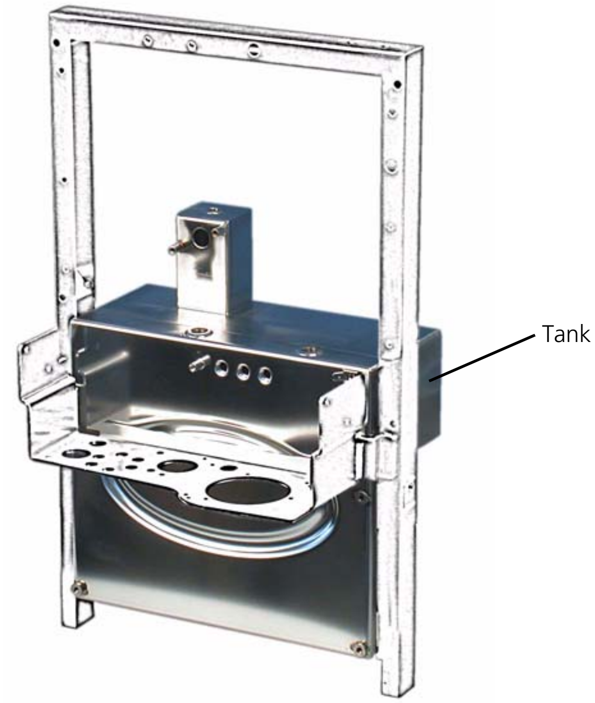


Figure 11-221. The tank/chassis

Note
The connectors are often referred to as “flow restrictors” even though the restrictor is only a part of the connector.

There are two kinds of flow restrictor:

- The older sintered disk “pill”, as shown in Figure 11-222 on page 11-200. The flow-restrictor connector (PN 155265), is shown with the “pill” inside clearly visible.
- The newer simple orifice. The newer orifice type is found only on the new flow-restrictor connectors (PN 155716) on the new mixer block (PN 155587). (The older style mixer block, PN 155333, uses a restrictor “pill”).

GALILEO uses a total of six flow-restrictor connectors. These are shown in:

- Figure 11-223, *The three flow restrictors for the Flow Sensor rinse flow, and the Paux rinse flow*, on page 11-202
- Figure 11-224, *The flow restrictor for the tank to oxygen-cell flow*, on page 11-202
- Figure 11-225, *The two flow restrictors for the mixer-block to oxygen-cell flows*, on page 11-203

Figure 11-222. Details of a connector containing a "pill" flow restrictor

11.32.3 Purpose

Tank

The purpose of the tank is to supply air and oxygen, mixed in the correct ratio, at a fairly constant pressure to:

- The *inspiratory (servo) valve*
- The *nebulizer compressor*
- The *Flow Sensor* (for the *rinse flow*)
- The *Paux* auxiliary pressure outlet (for the auxiliary pressure rinse flow)
- The *oxygen cell* (to provide a sample for measurement)

For a full description of rinse flows, see *Rinse flow* on page 11-81.

For information about gas-flows to and from the tank in the context of the complete pneumatic system, see Section 2.2, *Components managing the principle gas flow*, on page 2-2, and all the following sections.

"Pill" flow restrictors

The purpose of the sintered disk "pill" flow restrictors is simply to reduce gas-flow.

The flow restrictors in the tank reduce the flow of gas from the tank to:

- The *Flow Sensor* (for the *rinse flow*).
- The *Paux* auxiliary pressure outlet (for the auxiliary pressure rinse flow).
- The *oxygen cell* (to provide a sample for measurement).

The two flow restrictors in the mixer block reduce the flow of oxygen and air to the oxygen cell. (These flows are used for oxygen cell calibration.)

Note
Other sintered disks in GALILEO have different functions. See Section 11.25, *Mixer block*, on page 11-135, and Section 11.33, *Tank overpressure-relief valve and sintered disk*, on page 11-208.

11.32.4 Description and function

Tank

The tank is a stainless steel vessel holding 5.8 liters of gas at 200 to 350 mbar above atmospheric pressure.

Because of its relatively large volume, the tank has a buffering effect on the flow of gas through it, thereby ensuring that the outflow to the inspiratory valve and other components is much smoother than the inflow from the *mixer valves*. A further advantage of its large volume is that it is able to supply high peak flows when required.

Most gas mixing takes place in the tank.

Flow restrictors

See *"Pill" flow restrictors* on page 11-200.

11.32.5 Further information

The tank is not a sensitive part of GALILEO. However, it is important that all connections to the tank are completely gas-tight, and that none are damaged by cross-threading.

CAUTION
The tank and the chassis form a single unit. Therefore, if any of the tank's inlet or outlet connections are damaged, you must replace the complete tank/chassis unit. To do this, GALILEO must be completely disassembled.

11.32.6 Managing tank connections and "pill" flow restrictors

This section explains:

- How to replace the flow restrictors mounted on the tank and mixer block.
- How to cancel the rinse flow to the *Paux* auxiliary pressure outlet. (You cannot cancel—and there is no reason to cancel—the rinse flow to the *Flow Sensor*.)

11.32.6.1 Replacing flow restrictors

Removing old flow restrictors

1. Open GALILEO, as explained in Section 11.4, *Opening the main enclosure*, on page 11-4.

2. Identify the flow restrictors you want to replace.
   - Figure 11-223 shows the Paux and Flow Sensor rinse-flow flow-restrictors
   - Figure 11-224 shows the flow restrictor for the sample gas-flow from the tank to the oxygen cell. (This flow enables the cell to measure the oxygen in the gas supplied to the patient.)
   - Figure 11-225 shows the flow restrictors for the calibration gases from the mixer block to the oxygen cell.

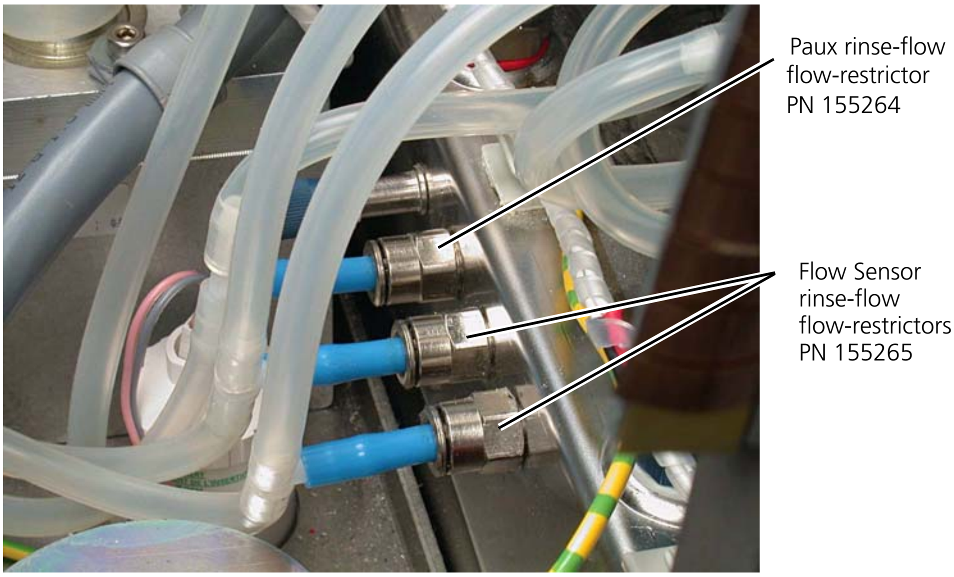


Figure 11-223. The three flow restrictors for the Flow Sensor rinse flow, and the Paux rinse flow

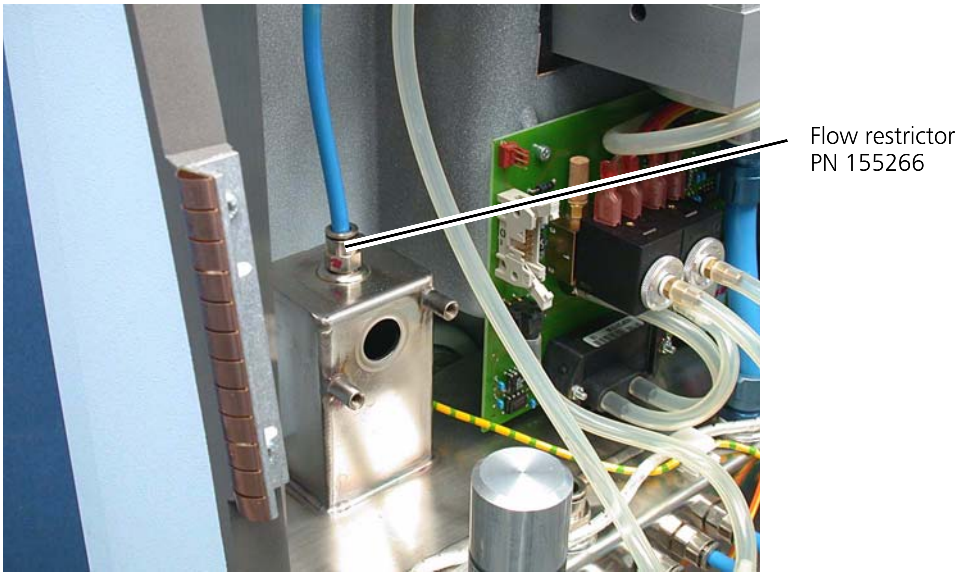


Figure 11-224. The flow restrictor for the tank to oxygen-cell flow

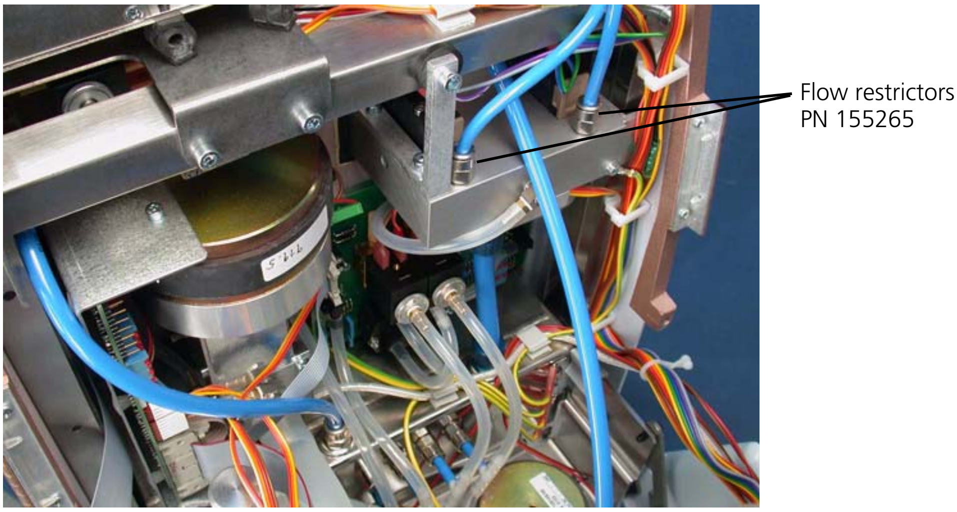


Figure 11-225. The two flow restrictors for the mixer-block to oxygen-cell flows

3. If you must remove flow restrictor PN 155266 (Figure 11-224), remove the inspiratory valve now, as described in Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111.
4. Remove the blue tube from the flow restrictor you want to replace. To do this, push down on the innor collar of the connector with a suitable spanner, while pulling up the blue tubing.

   Figure 11-190 on page 11-172 shows removal of a tube from one of the mixer-block flow restrictors.

Figure 11-226. Removing the tube from a mixer-block flow restrictor

5. Unscrew the connector containing the flow restrictor.

Figure 11-190 on page 11-172 shows removal of one of the mixer-block flow-restrictor connectors.

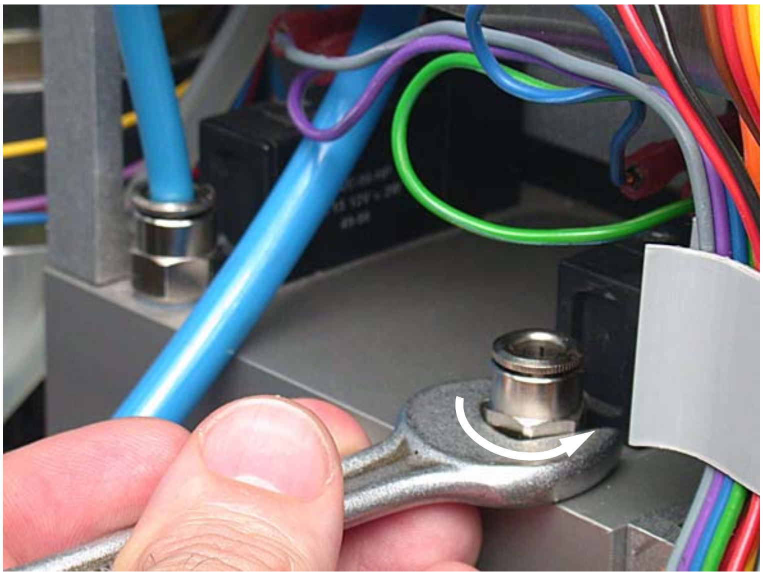


Figure 11-227. Unscrewing the flow-restrictor connector

Fitting new flow restrictors

To fit new flow restrictors, you essentially reverse the removal procedure. However, note the following points:

- Fitting the blue tubes into the flow-restrictor connectors is very easy: you simply push each tube into place.
- If you had to remove the inspiratory (servo) valve, be sure to perform the actions in the section *Fitting the new valve / servo board assembly* on page 11-115.

Testing

WARNING

You must perform all the following tests.

After fitting a new flow restrictor, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
  - Section 9, *Running Original or Upgrade 1 test software*
  - Section 10, *Running Upgrade 2 test software*

11.32.6.2 Cancelling the auxiliary-pressure rinse-flow

WARNING

In some circumstances (for example, when measuring esophagal pressure) it is vital that you cancel the Paux rinse flow.

1. Open GALILEO, as explained in Section 11.4, *Opening the main enclosure*, on page 11-4.
2. Locate the auxiliary pressure (Paux) rinse-flow flow-restrictor/connector on the tank. (Figure 11-223 on page 11-202 and Figure 11-228 below.)

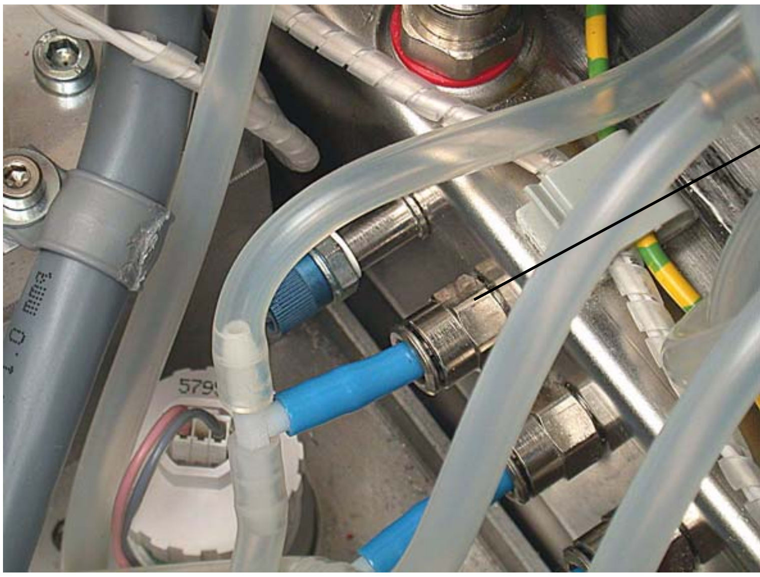


Figure 11-228. Position of auxiliary-pressure rinse-flow connector

3. Remove the blue tube from the flow restrictor. To do this, push down on the innor collar of the connector with a suitable spanner, while pulling off the blue tubing. (Figure 11-229.)

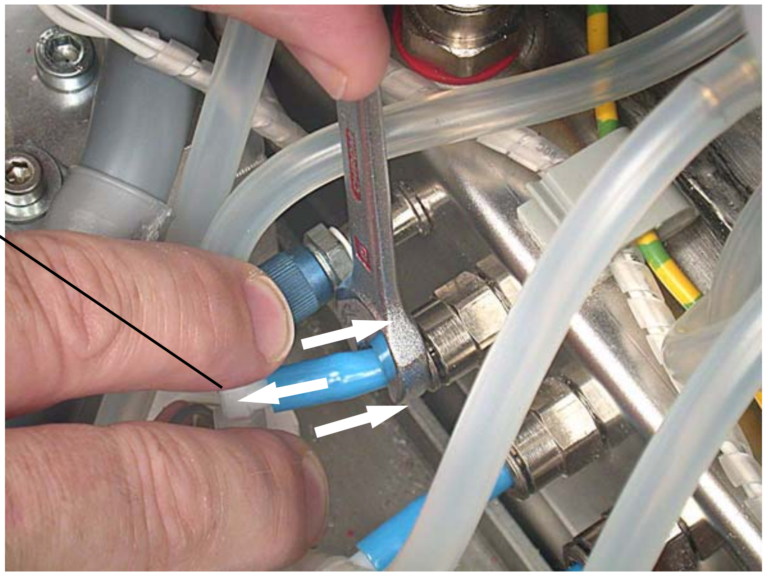


Figure 11-229. Removing the blue tube

4. Remove the blue collar from the stud to the left of the flow restrictor. (Figure 11-230.)

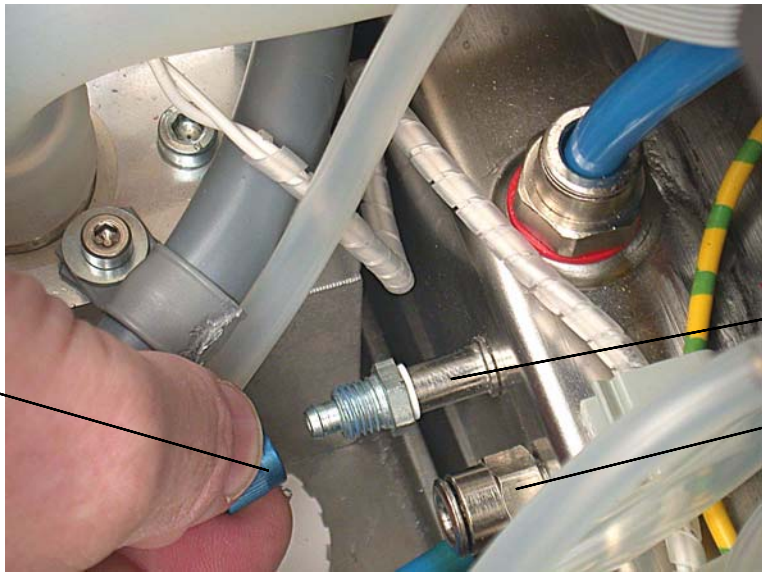


Figure 11-230. The collar removed

5. Fit the auxiliary pressure tube to the stud, using the collar. (Figure 11-231.)

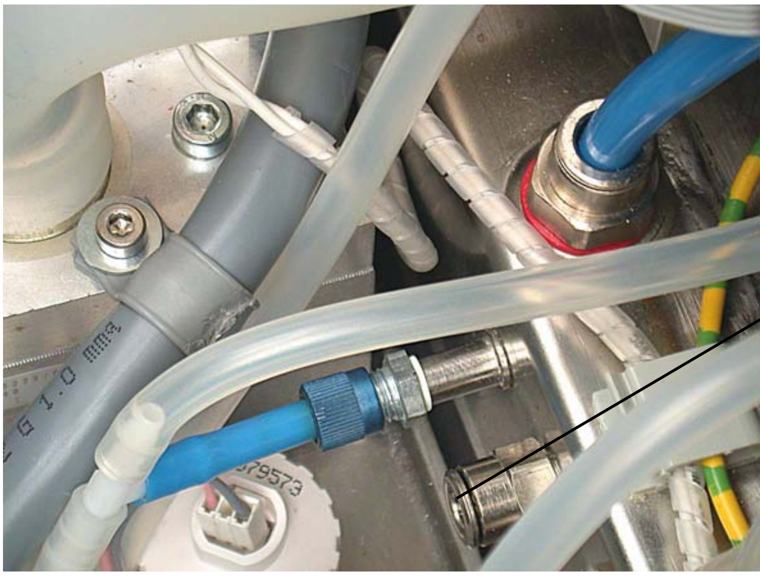


Figure 11-231. The auxiliary pressure tube secured on the stud

Note
Leave the auxiliary-pressure rinse-flow connector empty. It does not require a plug.

6. Close GALILEO.

Testing

WARNING
You must perform all the following tests.

After cancelling the auxiliary rinse flow, perform all the tests in:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
  - Section 9, *Running Original or Upgrade 1 test software*
  - Section 10, *Running Upgrade 2 test software*

11.33 Tank overpressure-relief valve and sintered disk

CAUTION

Do not attempt to repair overpressure-relief valve or the sintered disk. (Although you are permitted to replace the sintered disk.) HAMILTON MEDICAL AG does not permit anyone to make any repairs in the field at at level lower than the smallest parts provided in Appendix H, *Spare parts*.

11.33.1 References

- Position in gas-flow and in enclosure: Section 2.4, *Components managing the patient and tank overpressure-relief gas-flows*, on page 2-12
- Testing:
  - TSW 10.6, *Performing the tank overpressure-valve check*, on page 9-50.

  Or:
  - Unit 10.6, *Performing the tank overpressure-valve check*, on page 10-61.
- Part numbers:
  - Overpressure-relief valve: PN 155187, shown in Appendix H.10, *Valves and assembly groups*, on page H-8.
  - Sintered disk: PN 153639, shown in Appendix H.19, *Miscellaneous*, on page H-21.

11.33.2 Placement

The tank overpressure-relief valve is hidden behind the sintered disk at the rear of GALILEO, as shown in Figure 11-232 below, and more clearly in Figure 2-3, *Components managing the overpressure-relief gas-flows*, on page 2-12.

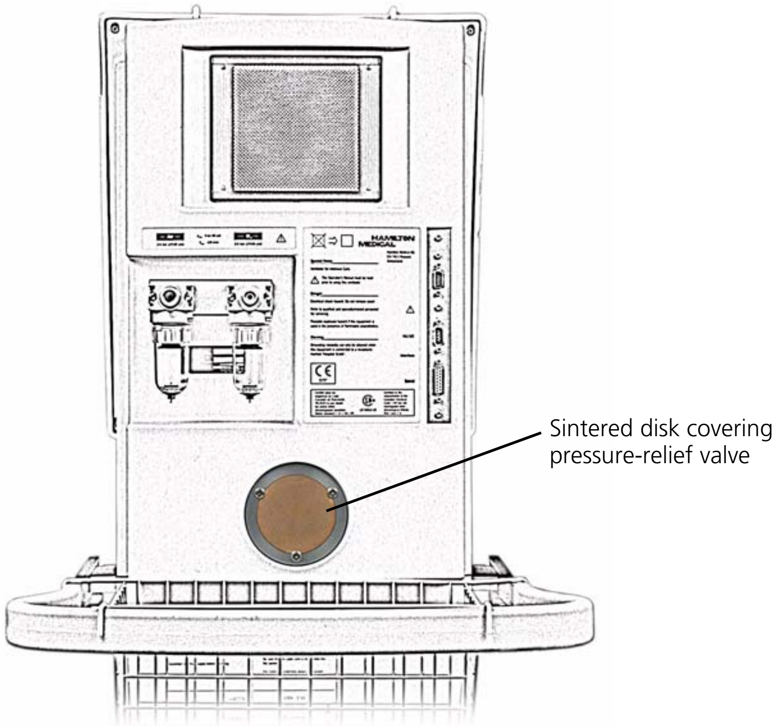


Figure 11-232. The position of the tank overpressure-relief valve

11.33.3 Purpose

Tank

The purpose of the tank overpressure valve is to release excess pressure from the *tank*.

Sintered disk

The purpose of this sintered disk is to act as a ***sound absorber*** for the tank overpressure valve.

Note
The other sintered disks in GALILEO, namely the sintered disk in the *mixer*, and the sintered disk "pills" act as ***flow restrictors***.

11.33.4 Description and function

The overpressure relief valve is a simple mechanical valve comprising housing, plunger and spring. (Figure 11-233 and Figure 11-234.) It is not electronically controlled.

Figure 11-233. Tank side of tank overpressure valve

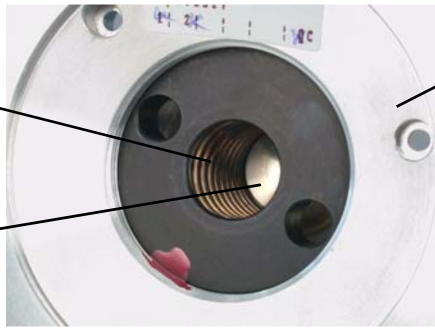


Figure 11-234. Ambient side of tank overpressure valve (detail)

The valve opens due to overpressure in the tank. This can occur in two circumstances:

- During a severe internal failure in GALILEO, for instance, the non-closure of one of the *mixer valves*.
- When a user makes a change to the air/oxygen mixture that GALILEO delivers to the patient. In this case, GALILEO flushes the tank with large quantities of air or oxygen, to achieve the required mixture in the tank as quickly as possible.

11.33.5 Further information

You cannot adjust, repair or clean the overpressure valve.

You can replace the sintered disk separately from the valve.

11.33.6 Replacing the sintered disk and tank overpressure relief valve

Removing the old disk and valve

1. Remove the three small hexagonal-drive (Allen) screws and washers that secure the sintered disk. (Figure 11-235.)

CAUTION

Be careful the disk does not drop out.

Figure 11-235. Removing the sintered disk sound absorber

2. If required, remove the pressure relief valve. (Figure 11-236 and .Figure 11-237)

Figure 11-236. Unscrewing the tank-pressure relief valve

Figure 11-237. Removing the tank-pressure relief valve

Fitting the new sintered disk and valve

To fit the new sintered disk and valve, simply reverse the removal procedure.

Testing

WARNING

Replacing the sintered disk is very simple. However, because it is assumed that the reason for replacement was a malfunction of GALILEO, you must perform the following tests when you replace a disk or valve.

Perform TSW 10.6, *Performing the tank overpressure-valve check*, on page 9-50 or Unit 10.6, *Performing the tank overpressure-valve check*, on page 10-61, depending on the software revision you have.

If this test is satisfactory, perform all the test software tests, as shown below:

- Section 7, *Checking hardware, voltages, and interface*
- One of the following:
  - Section 9, *Running Original or Upgrade 1 test software*
  - Section 10, *Running Upgrade 2 test software*
-

Section
12 General troubleshooting

12.1 Introduction

This section is your main information resource for all troubleshooting. It is in three parts:

• Section 12.2, *Troubleshooting using technical faults*, on page 12-2	A complete list of technical events and technical faults, with suggested actions for troubleshooting each technical fault. Technical fault messages provide the quickest and easiest way of identifying and rectifying faults. Technical events can give background information that helps to resolve a technical fault.
• Section 12.3, *Troubleshooting using LEDs*, on page 12-59	A section describing how you can troubleshoot using the LEDs on: • Control boards of Upgrade 2 models • Power supply boards of all models • Interface boards of all models It is recommended that you use LEDs to identify and rectify a fault only when GALILEO fails to display a technical fault message when misfunctioning.
• Section 12.4, *Troubleshooting using general symptoms*, on page 12-66	A general section on troubleshooting, suited to problems that do not display technical faults or LED symptoms. Use this section if it is not practical to use either Section 12.2 or Section 12.3.

When troubleshooting, always use the best diagnostic information available. Ideally, troubleshoot by using technical fault messages. If no technical fault message is displayed, use LEDs. If this is not practical, go to Section 12.4, *Troubleshooting using general symptoms*, on page 12-66.

WARNING

After performing a repair or adjustment, always perform the complete range of tests described in Section 9, *Running Original or Upgrade 1 test software* or Section 10, *Running Upgrade 2 test software*.

12.2 Troubleshooting using technical faults

12.2.1 Technical faults compared to alarms and technical events

A technical fault has similarities to two other types of occurrence: technical events, and alarms. The following table shows the similarities and differences.

<table>
<tr><th></th><th>Number</th><th>Alarm triggered</th><th>Characteristics</th></tr>
<tr><td>Technical Faults</td><td>TF 5500
to
TF 9999</td><td>High</td><td>

Designed for users, as well as for development purposes.
Usually presented to the user in these ways:

A screen message, including a technical fault (TF) number, on a red (high priority alarm) background.
A message, including the same number, written to the event log. This can be viewed by running 17: Event log check & export, on page 10-94, or by selecting Event Log during ventilation (displayed for the current session only).
A high priority audible patient alarm that sometimes cannot be silenced by the user. (This takes the form of five beeps, continuously repeated, from the loudspeaker. In some cases, it is accompanied by the buzzer.)

Sometimes GALILEO goes into the ambient state. (In this state, the patient can inspire and exhale (if he or she is able to do so) but is not assisted in any way by GALILEO.
Usually concern a pneumatic, electronic, or software error within GALILEO.
Always requires intervention from a HAMILTON MEDICAL engineer or from HAMILTON MEDICAL AG.
Sometimes reversible: the alarm sometimes cancels if the condition causing it corrects itself.
</td></tr>
<tr><td>Alarms</td><td>None</td><td>Low, medium, or high</td><td>

Designed for users.
Presented to the user in these ways[a]:

A screen message without a number, on a red (high priority alarm) or yellow (medium or low priority alarm) background.
A message written to the event log. This can be viewed by running 17: Event log check & export, on page 10-94 when using software version 3.3* or by selecting Event Log during ventilation (displayed for the current session only).
A sequence of five beeps (high priority), three beeps (medium priority), or two beeps (low priority) from the loudspeaker. These alarms can be silenced by the user.

Usually concerns user activity, or a problem with the status of the patient, or the status of the gas or power supply to GALILEO[a].
Usually require intervention by the user[a].
Reversible: the alarm automatically cancels if the condition causing it corrects itself.
</td></tr>
<tr><td>Technical Events</td><td>TF 80 to
TF 2999[b]</td><td>None</td><td>

Designed for development purposes, not users.
They often form a part of a series of events that leads to a major technical fault. In this case, they can help developers to understand the cause of a major technical fault.
Usually not presented to the user in any way:

Not displayed on screen.
Not displayed by selecting Event Log during ventilation.
Not displayed by viewing the event log in 17: Event log check & export, on page 10-94 (however, can be displayed by viewing the exported event log).
No audible warning given.

Usually concern software exception handling.
Usually self-correcting.
User intervention never required.
</td></tr>
</table>

Table 12-1. Characteristics of technical faults, alarms, and technical events

a. For more information, see the appropriate operator's manual.
b. Perhaps confusingly, technical events are prefaced by the letters "TF".

12.2.2 List of all technical events

Note

- Technical event messages are prefaced by the letters “TF” even though they are not technical faults.
- Technical events are numbered from 80 to 2999.

80 to 100	Trigger condition: Cancel condition: Note:	• *GMP* to CPU load out of range. • *GMP* to CPU load within range. • For TF 80, load is 80%. • For TF 81, load is 81%, and so on.
	GALILEO’s response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO’s ability to ventilate a patient is not compromised.
1100 1101 1102 1103 1104 1105	Trigger condition: Cancel condition:	• GALILEO cannot open, cannot write to, or cannot read the *event log*, or the checksum test, performed on the event log or event log buffer, fails. • None.
	GALILEO’s response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can view or export the event log as described in *17: Event log check & export*, on page 10-94.) • Displays the technical event number on the screen. **Note** These are the only minor technical faults that cause a message to be displayed on the screen.
	Action required:	• None required. GALILEO’s ability to ventilate a patient is not compromised.
1200 1201 1202 1203 1204 1205 1206 1211	Trigger condition: Cancel condition:	• Problem while performing test software tests. • None.
	GALILEO’s response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO’s ability to ventilate a patient is not compromised.
1300	Trigger condition: Cancel condition:	• Undefined event occurred. • None.
	GALILEO’s response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO’s ability to ventilate a patient is not compromised.

1301	Trigger condition: Cancel condition:	• The sound process is created twice. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
1400 1401	Trigger condition: Cancel condition:	• Test on *GMP* shows it to be faulty. • One or more testbytes are received from the GMP.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
1500 1501	Trigger condition: Cancel condition:	• Could not open or could not load the colored icon file. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • GALILEO fails to complete the boot procedure, and does not function.
	Action required:	• Switch GALILEO off and on again. • If the problem repeats, contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).
1502	Trigger condition: Cancel condition:	• The string length of the alarm message including the date and time stamp is too long. • GALILEO automatically cancels the condition immediately.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Shortens date and time string.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
1600	Trigger condition: Cancel condition:	• Invalid or undefined event. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Ignores the event.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.

1601 1602	Trigger condition:	• GALILEO cannot read or cannot find its configuration file, or there is a syntax error in the file.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • In the event of a read problem or a syntax failure, GALILEO uses its standard configuration. • In the event of a write problem, GALILEO generates a new configuration file.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
1603	Trigger condition:	• GALILEO cannot save its configuration file.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
1604 1605 1606	Trigger condition:	• Incorrect entry in configuration file.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • In the event of an unrecognized entry, GALILEO ignores the entry. • In the event of a double entry, GALILEO uses the first entry of the pair. • In the event of an out-of-range value, GALILEO uses a value from its standard configuration.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
1607	Trigger condition:	• Language file or icons cannot be loaded.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Attempts to load the English language file. If this is not possible, generates major technical fault *8607* on page 12-34.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
1608	Trigger condition:	• Invalid or unknown option in the configuration file.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.

1609	Trigger condition: Cancel condition: GALILEO's response: Action required:	• Fault in the GUI table. • None. • Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • None required. GALILEO's ability to ventilate a patient is not compromised.
1610 1611 1612 1613 1614 1615 1616 1617 1618 1619 1620 1621	Trigger condition: Cancel condition: GALILEO's response: Action required:	• Invalid status reported when GALILEO attempts to read the ud_queue (user dialog and display manager process queue). • None. • Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Ignores the read attempt. • None required. GALILEO's ability to ventilate a patient is not compromised.
1622	Trigger condition: Cancel condition: GALILEO's response: Action required:	• GALILEO cannot close window after user changes ventilation mode. • None. • Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • After 10 attempts to close the window, no more attempts are made. • None required. GALILEO's ability to ventilate a patient is not compromised.
1623	Trigger condition: Cancel condition: GALILEO's response: Action required:	• GALILEO cannot change ventilation mode in response to user's input. (There is an invalid mode in shared memory, following a mode change by a user.) • None. • Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Reverts to CMV ventilation mode. • None required. GALILEO's ability to ventilate a patient is not compromised.
1624	Trigger condition: Cancel condition: GALILEO's response: Action required:	• GALILEO cannot change ventilation mode in response to user's input. (The selected mode is inconsistent with the configuration philosophy.) • None. • Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Reverts to a ventilation mode consistent with the configuration philosophy. • None required. GALILEO's ability to ventilate a patient is not compromised.

1625	Trigger condition:	• GALILEO cannot copy *event log* data from ZPRAM (zero power RAM) to the *CompactFlash* during boot.
	Cancel condition:	• None.
	GALILEO's response:	Minor technical faults from the last session, including this technical fault, are lost. (You can only see minor technical faults by exporting the event log to the CompactFlash. Other events can be viewed by selecting **Event Log** during ventilation, or by viewing event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
1626	Trigger condition:	• It is not possible to write to the event log during booting or closing of the start-up screen.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).
1628	Trigger condition:	• The new value of a setting does not correspond to the value that should be there.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
1629	Trigger condition:	• GALILEO cannot find an object in the GUI table.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
1630	Trigger condition:	• The patient breathing circuit is set to an unrecognized value while the TRC (tube resistance compensation) window is open.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Disables TRC (tube resistance compensation). • Displays the **Adult** window so that the TRC setting can be made.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.

1650 1680	Trigger condition: Cancel condition:	• A core dump occurred in GALILEO's operating system. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Creates a secondary, major, technical fault.
	Action required:	• None required. GALILEO's ability to ventilate a patient is probably not compromised.
1700	Trigger condition: Cancel condition:	• Synchronization error: the last breath could not be monitored properly. • Synchronizes with a following breath.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
1701	Trigger condition: Cancel condition:	• Invalid queue status given during read attempt. • Queue status valid at later read attempt.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Initializes the input queue.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
1800	Trigger condition: Cancel condition:	• GALILEO could not open the COM 1 port. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Cannot communicate with the external communication interface.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
1900	Trigger condition: Cancel condition:	• An error occurred while reading the queue. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Initializes the queue.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.

1901	Trigger condition: Cancel condition:	• Incorrect trend event received. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
1902	Trigger condition: Cancel condition:	• No more space in breath buffer. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Overwrites the oldest data in the breath buffer.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
1903	Trigger condition: Cancel condition:	• Timeout reached on display. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Refreshes display.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
1904	Trigger condition: Cancel condition:	• Invalid function. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Does not carry out function.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
1905	Trigger condition: Cancel condition:	• Access to shared memory not possible. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Does not carry out function.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.

2000	Trigger condition: Cancel condition:	• GALILEO cannot read ZPRAM (zero power RAM). • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2000 2001 2002 2003 2004 2005 2006 2007	Trigger condition: Cancel condition:	• ZPRAM (zero power RAM) checksum incorrect for control settings, backup settings, alarm limits, flow calibration, oxygen cell calibration, expiratory valve calibration or tightness test. • Checksum correct.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Uses standard settings where possible. • Can display one of the following messages: **Flow Cal needed** **O2 Cal needed** **Expi Cal needed**
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2100	Trigger condition: Cancel condition:	• Testbyte received from *GMP* fails twice to correspond with expected value. • Testbyte from GMP must correspond twice with expected value.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2101 2102	Trigger condition: Cancel condition:	• GPT received invalid communication. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Ignores the communication to the GPT.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2103 2104	Trigger condition: Cancel condition:	• GALILEO cannot read input queue. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Initializes, or deletes and initializes queue.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.

2105	Trigger condition:	• GPT received invalid communication.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Ignores the communication to the GPT.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2200 2201 2202 2203 2204 2205 2206 2207 2208	Trigger condition:	• DPRAM communication error.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Ignores the communication to the GPT.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2209	Trigger condition:	• Testbyte received from *GCP* fails twice to correspond with expected value.
	Cancel condition:	• Testbyte from GCP must correspond twice with expected value.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2300	Trigger condition:	• Unknown or undefined event received.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Ignores the event.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2301	Trigger condition:	• One of the following received: unknown ventilation mode requested; incompatible mode requested as backup mode; invalid test software mode requested; apnea event in the context of an invalid ventilation mode.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Ignores apnea event. • Does not change ventilation mode (with the exception of changing to CMV in backup mode.)
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.

2302	Trigger condition: Cancel condition:	• Incorrect setting made by user. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Ignores setting.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2303	Trigger condition: Cancel condition:	• Unknown patient circuit event received. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Ignores event.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2304 2305	Trigger condition: Cancel condition:	• Calibration value (Flow Sensor, autozero value, expiratory valve, tightness test or oxygen cell) contains an undefined status. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Ignores undefined status.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2306 2307 2400	Trigger condition: Cancel condition:	• Unknown backup event or alarm received. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Ignores event.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2401	Trigger condition: Cancel condition:	• Invalid alarm number received. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Ignores event.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.

2402	Trigger condition:	• Number of *GCP* interrupts outside of tolerance over a period of 500 ms. (Can occur during startup and self-test.)
	Cancel condition:	• Number of GCP interrupts within tolerance over a period of 500 ms.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Resets GCP.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2403	Trigger condition:	• No testbyte received from GPT in 3 s.
	Cancel condition:	• Testbyte received from GPT.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Repeats the sending of the last testbyte.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2404	Trigger condition:	• Alarm buffer is full. There is no room for any more active alarms.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Alarm is ignored.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2405 2406	Trigger condition: Cancel condition:	• Read status for alarm queue is invalid. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Initializes the alarm queue in some cases.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2407	Trigger condition:	• The alarm counter does not read zero, even though there are no alarms stored in the alarm buffer.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Corrects the alarm counter.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.

2408	Trigger condition: Cancel condition: GALILEO's response: Action required:	• The low pressure alarm limit is not correct in DPRAM. • None. • Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • None required. GALILEO's ability to ventilate a patient is not compromised.
2409	Trigger condition: Cancel condition: GALILEO's response: Action required:	• A message that expiratory valve calibration is needed, is held in ZPRAM (zero power RAM). • Expiratory valve is correctly calibrated. • Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Creates the low priority alarm **Exp. valve calibration needed**. • Sounds high-priority alarm. • None required. GALILEO's ability to ventilate a patient is not compromised.
2410 2411 2412 2413	Trigger condition: Cancel condition: GALILEO's response: Action required:	• Undefined *GCP* bit. • None. • Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Ignores the undefined bit. • None required. GALILEO's ability to ventilate a patient is not compromised.
2414	Trigger condition: Cancel condition: GALILEO's response: Action required:	• One of the following two things occurred: The *GCP* received two consecutive faulty testbytes, or no testbytes over a period of 100 ms. • The testbyte is correctly received one time. • Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Ignores the undefined bit. • None required. GALILEO's ability to ventilate a patient is not compromised.
2415 2416	Trigger condition: Cancel condition: GALILEO's response: Action required:	• Failure of alarm buffer. • None. • Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • None required. GALILEO's ability to ventilate a patient is not compromised.

2417	Trigger condition:	• The checksum for the alarm limits held in ZPRAM (zero power RAM) is invalid.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Uses the default alarm limits.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2418	Trigger condition:	• Undefined return queue for expired jobs.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Does not send the event.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2419	Trigger condition:	• Undefined alarm initialization type (neither Standard, Last, nor Auto).
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Initializes the alarm using Standard.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2420 2421	Trigger condition:	• GALILEO tried to write over or under the alarm buffer's upper or lower limit.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2422 2423 2424 2425 2426 2427 2428 2429	Trigger condition:	• Error in the alarm buffer.
	Cancel condition:	• None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • With TF 2429 only, initializes the alarm buffer index.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.

2430	Trigger condition:	• Undefined case of apnea.
	Cancel condition:	• None.
	GALILEO’s response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Displays an **Apnea alarm** patient alarm.
	Action required:	• None required. GALILEO’s ability to ventilate a patient is not compromised.
2431 2432 2433	Trigger condition:	• Apnea alarm detected (timer expired) at a time when apnea is not expected (for example, when in a mechanical ventilation mode, during a disconnection alarm, or during a breath-hold maneuver).
	Cancel condition:	• None.
	GALILEO’s response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Displays an **Apnea alarm** patient alarm for TF 2432. Note, however, that this is for safety reasons only, and it is likely that there is no apnea incident. (This technical fault can be caused by putting GALILEO on hold, or some other interrupt in ventilation.) • Displays no alarm for TF 2431 and 2433.
	Action required:	• None required. GALILEO’s ability to ventilate a patient is not compromised.
2434	Trigger condition:	• It is not possible to read the saved alarm messages from the SRAM buffer.
	Cancel condition:	• None.
	GALILEO’s response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Empties the alarm buffer.
	Action required:	• None required. GALILEO’s ability to ventilate a patient is not compromised.
2435	Trigger condition:	• The *GCP* alarm counter appears faulty.
	Cancel condition:	• None.
	GALILEO’s response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO’s ability to ventilate a patient is not compromised.
2436	Trigger condition:	• Problem with apnea alarm handler.
	Cancel condition:	• None.
	GALILEO’s response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. GALILEO’s ability to ventilate a patient is not compromised.

2437	Trigger condition: Cancel condition:	• The GPT version appears to be incorrect when it is downloaded. • The GPT version is seen to be correct at a later download.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Performs a second request to the GPT. • Causes TF 9414 or 9415 if the version does not match after the second request.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2800	Trigger condition: Cancel condition:	• Application shut down by manual user input. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• None required. This technical fault can only occur in a development environment.
2801	Trigger condition: Cancel condition:	• GCP watchdog interrupt interval is out of range at startup. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Logs the GCP watchdog interrupt interval (nominally 500ms) for debugging or performance measurement purposes.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2802	Trigger condition: Cancel condition:	• Number of GCP watchdog interrupts is out of range at startup. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Logs the number of GCP interrupts within the watchdog interval for debugging or performance measurement purposes.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.
2803	Trigger condition: Cancel condition:	• Technical fault 2801 or 2802. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Logs the absolute time required to identify the occurrence of TF 2801 or 2802.
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.

2804	Trigger condition: Cancel condition:	• Technical fault 2801 or 2802. • None.
	GALILEO's response:	• Writes the technical event number in the event log. (You cannot see this by selecting **Event Log** during ventilation. However, you can export the event log as described in *17: Event log check & export*, on page 10-94.) • Suppresses multiple entries of other watchdog events (such as TF 2801 and 2802).
	Action required:	• None required. GALILEO's ability to ventilate a patient is not compromised.

12.2.3 List of all technical faults

Note

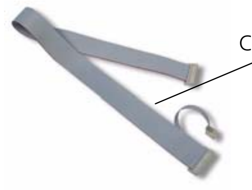
If you have a technical fault (not a technical event), HAMILTON MEDICAL AG requests that you export the event log and send it to HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). When you report a technical fault, be careful to note:

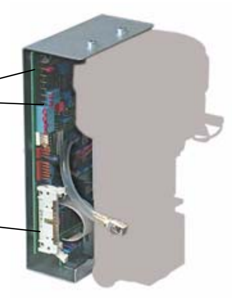
- Technical fault number
- GALILEO serial number
- Software version of unit

5500	Trigger condition: Cancel condition:	• The power supply for the servo board stays out of range for 1 s. (Range = 10 V ±1%). • The signal returns to a value within range.
	GALILEO's response:	• Sounds high-priority alarm that cannot be silenced by the user. • Displays the technical fault number on the screen, against a red background. • Enters *ambient state* (however, this is reversible, if the cancel condition is met). • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)

5500... Action required:

- Remove the patient from GALILEO and secure alternative ventilation.
- Check the 10 V power supply on the servo board, using a voltmeter. To do this:
  - Remove the large ribbon cable from the servo board (PN 155246).





  - Measure between test pin 2 (second pin from top) and ground (top pin).
  - If not in range, replace the inspiratory (servo) valve and board (Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111). If in range, replace the cable, and continue below.
- Check the 10 V supply on the *control board* as described in either Table 7-3, *Pin voltages on control board 155461/xx*, on page 7-7, or Table 7-2, *Pin voltages on control board 155154/xx*, on page 7-6. If not in range, check cable from connector P307 on the *control board* to connector P104 on the servo board. (Part number of cable is PN 155246, shown in Appendix H.11, *Cables* on page H-11.) If this connection is not faulty, continue below.
- Check the power supply from the column. (See Section 12.3.2, *Power supply board LED troubleshooting*, on page 12-62.). If the power supply is faulty, replace it. If it is not faulty, continue below.
- If you are running original or Upgrade 1 software, perform Test 6.4, *Performing all checks*, on page 9-22, checking **ADC 15**. If the value is out of range, replace the *control board*. (See Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.)
- If you are running Upgrade 2 test software, perform Unit 6.4, *Performing all checks*, on page 10-28, checking **ADC 15**. If the value is out of range, replace the control board. (See Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.)
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

5501 Trigger condition:
- The power supply for the sensor board stays out of range for 1 s. (Range = -10 V ±1%).

Cancel condition:
- The signal returns to a value within range.

GALILEO's response:
- Sounds high-priority alarm that cannot be silenced by the user.
- Displays the technical fault number on the screen, against a red background.
- Enters *ambient state* (however, this is reversible, if the cancel condition is met).
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Check the -10 V power supply on the sensor board, using a voltmeter. To do this, measure between test pin 2 (second pin from top) and ground (top pin) on the sensor board.

If not in range, replace the sensor board (Section 11.31.4, *Replacing the sensor board*, on page 11-195). If in range, continue below.
- Check the 10 V supply on the *control board* as described in either Table 7-3, *Pin voltages on control board 155461/xx*, on page 7-7, or Table 7-2, *Pin voltages on control board 155154/xx*, on page 7-6. If not in range, check cable from connector P307 on the *control board* to connector P201 on the sensor board. (Part number of cable is PN 155246, shown in Appendix H.11, *Cables* on page H-11.) If this connection is not faulty, continue below.
- Check the power supply from the column. (See Section 12.3.2, *Power supply board LED troubleshooting*, on page 12-62.). If the power supply is faulty, replace it. If it is not faulty, continue below.
- If you are using original or Upgrade 1 software, perform Test 6, *A/D Conversion*, on page 9-22 for the channel named **ADC 14**. If the value is out of range, replace the *control board*. (See Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.)
- If you are using Upgrade 2 software, perform Test 10.4, *Performing the mixer valves checks*, on page 10-58 for the channel named **ADC 14**. If the value is out of range, replace the control board. (See Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.)
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

5502	Trigger condition:	• The +15 V signal stays out of range on the *control board* for 1 s. (Range: 15.00 V ±10%.) • The A/D converter is out of specification.
	Cancel condition:	• The signal returns to a value within range.
	GALILEO's response:	• Sounds high-priority alarm that cannot be silenced by the user. • Displays the technical fault number on the screen, against a red background. • Enters *ambient state* (however, this is reversible, if the cancel condition is met). • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Check the cables to the *control board*. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
5503	Trigger condition:	• The 15 V ground signal stays out of range for 1 s. (Range: 15.00 V ±05 mV.) • The A/D converter is out of specification. • The power supply monitor for the servo and sensor boards is out of specification.
	Cancel condition:	• The signal returns to a value within range. • The A/D converter returns to specification.
	GALILEO's response:	• Sounds high-priority alarm that cannot be silenced by the user. • Displays the technical fault number on the screen, against a red background. • Enters *ambient state* (however, this is reversible, if the cancel condition is met). • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Check the cables to the *control board*. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

5505 5506 5507	Trigger condition:	• The tank pressure stays above 550 mbar for 50 ms, indicating that one of the mixer valves is leaking. (TF 5505.) • The *Error P Tank signal* on the *servo board* stays high (active) for 5 s, showing that tank pressure is too high. This indicates that one of the *mixer valves* is leaking. (TF 5506.) • The air inlet valve or the oxygen inlet valve (the mixer valves) cannot close properly. (TF 5507.)
	Cancel condition:	• The faulty mixer valve is replaced.
	GALILEO's response:	• Sounds high-priority alarm that cannot be silenced by the user. • Displays the technical fault number on the screen, against a red background. • Enters *ambient state* (however, this is reversible, if the cancel condition is met). • Disables the mixer. • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • If you are running original or Upgrade 1 test software, perform Test 10.4, *Performing the mixer valves checks*, on page 9-48, and follow the troubleshooting instructions. • If you are running Upgrade 2 test software, perform Test 10.4, *Performing the mixer valves checks*, on page 10-58, and follow the troubleshooting instructions. • Replace the *mixer valves*. (Section 11.25.5, *Replacing the mixer block or mixer valves*, on page 11-144.). • Replace the *sensor board*. (Section 11.31.4, *Replacing the sensor board*, on page 11-195.) • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
5508	Trigger condition:	• Running GALILEO using non-production software.
	Cancel condition:	• Running GALILEO with publicly released, production software.
	GALILEO's response:	• Gives an acoustic signal during the startup procedure. • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Ventilates normally, but disables some alarms.
	Action required:	• Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). • Replace the affected program carriers (for example, the *GCP* or *GMP software CompactFlash*) with officially released software. **WARNING** **Never use software of this kind in a clinical environment.**

5509	Trigger condition:	• The Error Servo signal (a hardware signal from the servo board to the *control board*) stays high (active) for 5 s. This indicates that the *inspiratory (servo) valve* is not functioning properly.
	Cancel condition:	• None.
	GALILEO's response:	• Sounds high-priority alarm that cannot be silenced by the user. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
	Action required:	• If you have inspiratory valve/servo board module PN 155496, shown in Appendix H.10, *Valves and assembly groups* on page H-8, this problem could be caused by the 20 ml/s potentiometer on the servo board being very much out of range. Try to correct this problem by resetting the potentiometer as described in: • Test 12.3, *Performing the inspiratory-valve airtightness check*, on page 9-57 (original or Upgrade 1 test software) • Unit 12.3, *Performing the inspiratory-valve airtightness check*, on page 10-68 (Upgrade 2 test software). • Replace *inspiratory (servo) valve*. (Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111.) • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
5510	Trigger condition:	• The *dP Flow Sensor* signal is on two consecutive occasions higher than 8.75 V. This means that one or both autozero valves are not switching. **Note** If the first autozero calibration is faulty, the procedure is repeated immediately.
	Cancel condition:	• Cancelled at the start of the next Flow Sensor calibration.
	GALILEO's response:	• Sounds high-priority alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Continues to ventilate patient.

Action required:

- Check cable PN 155184 between the autozero valves and the connector board.

If it is not faulty, replace the connector board. (Section 11.10.6, *Replacing the connector board*, on page 11-40.)

- Replace the *sensor board*. (Section 11.31.4, *Replacing the sensor board*, on page 11-195.)
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

5511 Trigger condition:

- The *dP Flow Sensor* signal is on two consecutive occasions not at 0 ±0.6 V at the time the *Flow Sensor autozero valves* open to ambient air for the autozero procedure.

Note
If the first autozero calibration is faulty, the procedure is repeated immediately.

Cancel condition:

- Cancelled at the start of the next Flow Sensor calibration.

GALILEO's response:

- Sounds high-priority alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Continues to ventilate patient.

Action required:

- Perform one of the following:
  - Original or Upgrade 1 software: Test 8.5, *Performing the dP Flow Sensor zero calibration*, on page 9-32.
  - Upgrade 2 software: Unit 8.5, *Performing the dP Flow Sensor zero calibration*, on page 10-40.
- Check cable PN 155184 between the autozero valves and the connector board.

  If it is not faulty, replace the connector board. (Section 11.10.6, *Replacing the connector board*, on page 11-40.)
- Replace the *sensor board*. (Section 11.31.4, *Replacing the sensor board*, on page 11-195.)
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

5512 Trigger condition:

- The *Paw* pressure sensor is on two consecutive occasions not at 0 ±0.5 V at the time the *Flow Sensor autozero valves* close for the autozero procedure.

Note
If the first autozero calibration is faulty, the procedure is repeated immediately.

Cancel condition:

- Cancelled at the start of the next Flow Sensor calibration.

GALILEO's response:

- Sounds high-priority alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Continues to ventilate patient.

Action required:

- Perform Test 8.3, *Performing the Ppat, Paw, Paux, and dP Servo zero calibrations*, on page 9-31 or Unit 8.3, *Performing the Ppat, Paw, Paux, and dP servo zero calibrations*, on page 10-37, for the Paw zero potentiometer.
- Check cable PN 155184 between the autozero valves and the connector board.

If it is not faulty, replace the connector board. (Section 11.10.6, *Replacing the connector board*, on page 11-40.)
- Replace the *sensor board*. (Section 11.31.4, *Replacing the sensor board*, on page 11-195.)
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

5513

Trigger condition:
- The Error Fan signal stays high (active) for longer than one second.

Cancel condition:
- The *Error Fan signal* stays low (inactive) for longer than one second.

GALILEO's response:
- Sounds high-priority alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Continues to ventilate patient.

Action required:
- Remove the patient from the ventilator (the ventilator could fail later).
- Ensure the fan cable is correctly connected.
- Ensure the fan is not physically blocked.
- If the fan ***does not*** turn when GALILEO is switched on, replace the fan. (Section 11.14.7, *Replacing the fan*, on page 11-73.) If this is not effective, replace the servo module (Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111).
- If the fan ***does*** turn when GALILEO is switched on, replace one of the following:
  - Servo module — if you have the **PAPST** fan PN 155230. (Section 11.22.6, *Replacing the inspiratory valve / servo board assembly*, on page 11-111.)
  - Control board — if you have the ***NMB*** fan PN 155423. (Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.)
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

5514

Trigger condition:
- There is no loudspeaker current during the window in which this is measured.

Cancel condition:
- Cancelled if there is a loudspeaker current during the measurement window.

GALILEO's response:
- Sounds high-priority alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Continues to ventilate patient.

Action required:
- If an acoustic alarm from the loudspeaker alone (not buzzer) is audible, you can ignore this technical fault (the fault detection is simply too sensitive).
- If no acoustic loudspeaker alarm is audible, do the following:
  - Check that the loudspeaker is connected.
  - Check that the loudspeaker is not damaged.
  - Check that no cables are loose or missing between the: *connector board* and *control board*.
  - Check that no cables are loose or missing between the *GMP* and the *control board*.
  - Update the GMP software to the latest version.

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

7400
7401
7402
7403
7404

Trigger condition:
- On-chip RAM or ROM error, or other error in the *GPT* during the boot process. (There is both RAM and ROM on the GPT processor.)

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Check that the *GPT* is properly inserted in its socket, and that the socket is not damaged.
- If you are running original or Upgrade 1 test software, perform *TSW 2: GPT-GMP Communication*, on page 9-6.
- If you are running Upgrade 2 test software, perform *2: GPT–GMP communication & LED checks*, on page 10-8.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

7405 7406	Trigger condition: Cancel condition:	• *GPT* receives no testbytes, or wrong testbytes from *GMP*. • Correct testbytes received.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Check that the *GPT* is properly inserted in its socket, and that the socket is not damaged. • If you are running original or Upgrade 1 test software, perform *TSW 2: GPT-GMP Communication*, on page 9-6. • If you are running Upgrade 2 test software, perform *2: GPT–GMP communication & LED checks*, on page 10-8. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
8000	Trigger condition: Cancel condition:	• Alarm queue could not be opened. It is not possible to give alarm messages. • Correct testbytes received.
	GALILEO's response:	• Sounds high-priority alarm (buzzer only). • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Check that the *GPT* is properly inserted in its socket, and that the socket is not damaged. • If you are running original or Upgrade 1 test software, perform *TSW 2: GPT-GMP Communication*, on page 9-6. • If you are running Upgrade 2 test software, perform *2: GPT–GMP communication & LED checks*, on page 10-8. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

8001
8002
8003

Trigger condition:
- User dialog and display manager process (uddm) monitoring, or trend queue cannot be initialized.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Continues to ventilate patient.

Action required:
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

8004
8005
8006

Trigger condition:
- Shared memory or real-time priority cannot be initialized.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Continues to ventilate patient.

Action required:
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

8007

Trigger condition:
- Development version of *GMP software CompactFlash* is installed that allows dumps of the trend data.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Continues to function normally.

	Action required:	• HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). • Replace the *GMP software CompactFlash* program carrier with officially released software. **WARNING** **Never use software of this kind in a clinical environment.**
8400 8401	Trigger condition: Cancel condition:	• Could not open input queue, or could not open shared memory. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
8402	Trigger condition: Cancel condition:	• Could not initialize real-time priority. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

8403	Trigger condition: Cancel condition:	• Could not read input queue. • None.
	GALILEO's response:	• Sounds high-priority alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Initializes input queue.
	Action required:	• Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
8500	Trigger condition: Cancel condition:	• Could not initialize graphics mode. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
8501 8502 8503	Trigger condition: Cancel condition:	• Could not open font file, could not open icon file, or could not load icons. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.

Action required:

- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

8504

Trigger condition:
- Object table faulty.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)

Action required:
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

8600

Trigger condition:
- Operating system error.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

8601 Trigger condition:
- Could not open input queue.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

8602
8603 Trigger condition:
- Could not initialize part of shared memory or could not initialize queues.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

8604 Trigger condition:
- ZPRAM (zero power RAM) test failed during initialization.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*.

	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
8605 8606	Trigger condition: Cancel condition:	• DPRAM failed. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
8607	Trigger condition:	• GALILEO could not find the file containing the icons or the file containing the language strings for British English.
	Cancel condition:	• None.
	GALILEO's response:	• Sounds high-priority alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Functions as normal, but the screen does not display words or does not display icons.
	Action required:	• Replace the *GMP software CompactFlash* as described in Section 11.19.5, *Replacing the GMP CompactFlash*, on page 11-101. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

8608 Trigger condition:
- Operating system error.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

8609 Trigger condition:
- Could not start the interface communication process.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Continues to function as normal, but cannot communicate to other equipment using the communication interface.

Action required:
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

8610 Trigger condition:
- Could not find an object in the GUI table.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:

- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

8611

Trigger condition:
- Could not find initialize monitor queue.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

8700
8701
8702

Trigger condition:
- Could not open shared memory.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

8703 8704 8705	Trigger condition: Cancel condition:	• Could not open input queue, or could not open output queue. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
8706	Trigger condition: Cancel condition:	• Operating system error. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
8707 8800 8801	Trigger condition: Cancel condition:	• Could not initialize queue. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.

Action required:

- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

8802 Trigger condition:

- GALILEO tried ten times to initiate communication through the communication interface, but failed each time.

Cancel condition:

- None.

GALILEO's response:

- Sounds high-priority alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Continues to ventilate patient.

Action required:

- Remove the patient from GALILEO and secure alternative ventilation.
- Ensure that the device connected to the communication interface can understand the HAMILTON MEDICAL AG or VueLink protocol. (For a list of devices, see Table B-6, *Alarm behavior with third party monitoring systems*, on page B-6.)
- Make sure the *GIP EPROM* is the latest version.
- Replace the *interface board*.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

8803 Trigger condition:

- Communication between the *GMP* and the *GIP* failed.

Cancel condition:

- None.

GALILEO's response:

- Sounds high-priority alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Continues to ventilate patient.

	Action required:	• Reconfigure GALILEO so that the communication interface is disabled. You can continue to ventilate the patient. • Ensure that the device connected to the communication interface can understand the HAMILTON MEDICAL AG or VueLink protocol. (For a list of devices, see Table B-6, *Alarm behavior with third party monitoring systems*, on page B-6.) • Make sure the *GIP EPROM* is the latest version. • Replace the *interface board*. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
9000	Trigger condition:	• Operating system error.
	Cancel condition:	• None.
	GALILEO’s response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
9001 9002 9003	Trigger condition:	• The ZPRAM (zero power RAM) test, which takes place during GALILEO’s boot process, failed. (The ZPRAM is positioned on the *control board*.)
	Cancel condition:	• None.
	GALILEO’s response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background. • Can lose latest setup details and the events from the last session with TF 9001.

	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Replace the *control board*. (See Section 11.11.6, *Replacing the control board and GMP assembly*, on page 11-52.) • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
9100 9101	Trigger condition: Cancel condition:	• GPT error. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
9102 9103 9104	Trigger condition: Cancel condition:	• Operating system error. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9105
9106
9107

Trigger condition:
- Could not open output queue, or could not open input queue.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9108

Trigger condition:
- Could not open shared memory.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9109

Trigger condition:
- The alarm watchdog process could not be performed.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • If you are running GALILEO original or Upgrade 1 software (software version 1 or 2), do the following: • Check the *alarm buffer* for earlier alarms or technical faults (especially TF 6000 to 9999) that could have caused this technical fault. • Check the *event log* for earlier alarms or technical faults (especially TF 6000 to 9999) that could have caused this technical fault. • Report any suspicious alarms or events to HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch) • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
9110	Trigger condition:	• The last four testbytes received from the *GCP* did not correspond to the value expected. There is a communication problem between the *GMP* and GCP.
	Cancel condition:	• Correct testbytes must be received.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • If you are running GALILEO original or Upgrade 1 software (software version 1 or 2), do the following: • Check the *alarm buffer* for earlier alarms or technical faults (especially TF 6000 to 9999) that could have caused this technical fault. • Check the *event log* for earlier alarms or technical faults (especially TF 6000 to 9999) that could have caused this technical fault. • Report any suspicious alarms or events to HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch) **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
9111	Trigger condition:	• Watchdog is inactive.
	Cancel condition:	• None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.

Action required:

- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9200
9201
9202
9203

Trigger condition:
- DPRAM error.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9204
9205

Trigger condition:
- Operating system error.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

9206	Trigger condition: Cancel condition:	• *GCP* gives testbyte error. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • If you are running GALILEO original or Upgrade 1 software (software version 1 or 2), do the following: • Check the *alarm buffer* for earlier alarms or technical faults (especially TF 6000 to 9999) that could have caused this technical fault. • Check the *event log* for earlier alarms or technical faults (especially TF 6000 to 9999) that could have caused this technical fault. • ContactHAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
9207 9208 9209	Trigger condition: Cancel condition:	• Cannot open output queue. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). • If you have a software version prior to GMP 02.12, update your software to the latest software version. **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9210 9211 9212

Trigger condition:
- Cannot open shared memory.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9213

Trigger condition:
- Alarm watchdog is not functioning.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Continues to ventilate patient normally.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9300 9301 9302

Trigger condition:
- Could not open output queue.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
9303 9304	Trigger condition: Cancel condition:	• Could not open shared memory • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
9305	Trigger condition: Cancel condition:	• Operating system error. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9306 Trigger condition:
- The *inspiratory (servo) valve* leak is higher than acceptable.

Cancel condition:
- The tightness test must show that the *inspiratory (servo) valve* leak is within range.

GALILEO's response:
- Sounds high-priority alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (However, this is reversible, if the cancel condition is met.)

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- If you are running original or Upgrade 1 test software, perform TSW 12.3, *Performing the inspiratory-valve airtightness check*, on page 9-57.
  If you are running Upgrade 2 test software, perform Unit 12.3, *Performing the inspiratory-valve airtightness check*, on page 10-68. (This can confirm whether or not there is a hardware error.)
- If you are running original or Upgrade 1 test software, perform *TSW 14: Servo and Flow Sensor*, on page 9-63.
  If you are running Upgrade 2 test software, perform *14: Inspiration valve check*, on page 10-75. (This can confirm whether or not there is a hardware error.)
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9400
9401
9402
9403
9404

Trigger condition:
- Cannot open alarm output queue.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9405
9406
9407
9408

Trigger condition: • Cannot open *GMP*, alarm, monitor or other shared memory.
Cancel condition: • None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9409

Trigger condition: • Operating system error.
Cancel condition: • None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9410

Trigger condition: • DRAM error.
Cancel condition: • None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.
- Loses some alarm functions.

Action required:

- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9411 Trigger condition:
- ZPRAM (zero power RAM) error.

Cancel condition:
- None.

GALILEO's response:

- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.
- Loses some alarm limits.

Action required:

- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9412 Trigger condition:
- *GCP* and *GMP software CompactFlash* software versions are incompatible.

9413 Cancel condition:
- None.

GALILEO's response:

- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:

- Remove the patient from GALILEO and secure alternative ventilation.
- Check GCP and GMP versions, according to Appendix C, *GMP software/hardware compatibility*. If necessary, contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch) for new software.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9414 9415	Trigger condition: Cancel condition:	• *GPT* and *GMP software CompactFlash* software versions are incompatible. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm, that the user cannot silence. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
9416	Trigger condition: Cancel condition:	• High pressure alarm limit value incorrect in DPRAM. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
9417	Trigger condition: Cancel condition:	• Apnea time value incorrect in DPRAM. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.

Action required:

- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9418
9419
9420

Trigger condition:
- *GCP* problem.

Cancel condition:
- None.

GALILEO's response:

- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:

- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9421

Trigger condition:
- The *GCP* has received four false testbytes consecutively, or has received no testbyte in the last 200 ms.

Cancel condition:
- None. (This technical fault can be caused by many conditions.)

GALILEO's response:

- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • If you are running GALILEO original or Upgrade 1 software (software version 1 or 2), do the following: • Check the *alarm buffer* for earlier alarms or technical faults (especially TF 6000 to 9999) that could have caused this technical fault. • Check the *event log* for earlier alarms or technical faults (especially TF 6000 to 9999) that could have caused this technical fault. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • ContactHAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
9422	Trigger condition: Cancel condition:	• Running GALILEO using non-production software that cancels the watchdog. • None.
	GALILEO's response:	• Sounds high-priority alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Ventilates normally, but alarms are suppressed.
	Action required:	• Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). • Replace the affected program carriers with officially released software. **WARNING** **Never use software of this kind in a clinical environment.**
9423	Trigger condition: Cancel condition:	• Cannot start time-out procedure for a procedure. • None.
	GALILEO's response:	• Sounds high-priority alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Continues to ventilate patient.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9424 Trigger condition: • Cannot communicate using user dialog and display manager process.
Cancel condition: • None.

GALILEO's response:
- Sounds high-priority alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Continues to ventilate patient.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Make sure that the GCP EPROM is properly seated. (Section 11.18, *GCP EPROM*, on page 11-97.)
- Replace the GCP EPROM. (Section 11.18, *GCP EPROM*, on page 11-97.)
- Replace the control board. (Section 11.11, *Control board and GMP assembly*, on page 11-45.)
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9700 Trigger condition: • *GCP* checksum error.
Cancel condition: • None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9701	Trigger condition: Cancel condition:	• One or more internal or external *GCP* RAM cell is faulty. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Replace the control board. (Section 11.11, *Control board and GMP assembly*, on page 11-45.) • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
9702	Trigger condition: Cancel condition:	• One or more DPRAM cell associated with communication is faulty. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Replace the control board. (Section 11.11, *Control board and GMP assembly*, on page 11-45.) • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9703 Trigger condition:
- While performing a self-test, the *GCP* did not recognize the *GMP* version.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- Check GCP and GMP versions, according to Appendix C, *GMP software/hardware compatibility*. If necessary, contact HAMILTON MEDICAL AG for new software.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9704 Trigger condition:
- The value of the A/D converter offset at the time the *GCP* starts, is out of specification; or the status of the A/D converter at time the GCP starts, is out of specification at startup.

Cancel condition:
- None.

GALILEO's response:
- Sounds high-priority (buzzer) alarm.
- Displays the technical fault number on the screen, against a red background.
- Writes the technical fault number in the event log. (You can see this by selecting **`Event Log`** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.)
- Enters *ambient state*. (This is not reversible.)
- Displays technical fault 9907 on the screen, against a red background.

Action required:
- Remove the patient from GALILEO and secure alternative ventilation.
- If you are running original or Upgrade 1 test software, perform *TSW 6: A/D Conversion*, on page 9-22.
- If you are running Upgrade 2 test software, perform *6: A/D converter check*, on page 10-26.
- Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.)
- Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note
If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9705	Trigger condition:	• The voltage of both D/A channels are out of specification at startup.
	Cancel condition:	• None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm, that the user cannot silence. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Perform the tests in Section 7.3, *Checking voltages*, on page 7-3. • If you are running original or Upgrade 1 test software, perform *TSW 7: D/A Conversion*, on page 9-25. • If you are running Upgrade 2 test software, perform *7: D/A converter check*, on page 10-30. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
9706	Trigger condition:	• Following a reset, communication between the *GMP* and the *GCP* could not be established before the expiration of the 40 s timeout.
	Cancel condition:	• None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9707	Trigger condition: Cancel condition:	• During the *GCP* selftest, the 5 V power supply is out of specification. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Perform one of the 5 V checks documented in step (2) on page 7-5 of Section 7, *Checking hardware, voltages, and interface*, on page 7-1. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.
9800 9801 9802 9803 9804	Trigger condition: Cancel condition:	• There is a *GMP* checksum error. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Change the GMP software. (See Section 11.19.5, *Replacing the GMP CompactFlash*, on page 11-101.) • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

9900 9901 9902 9903 9904 9905 9906 9907 9908	Trigger condition: Cancel condition:	• The watchdog detected that a process does not exist, or reacted too late. • None.
	GALILEO's response:	• Sounds high-priority (buzzer) alarm. • Displays the technical fault number on the screen, against a red background. • Writes the technical fault number in the event log. (You can see this by selecting **Event Log** during ventilation. Alternatively, you can view the event log as described in *17: Event log check & export*, on page 10-94.) • Enters *ambient state*. (This is not reversible.) • Displays technical fault 9907 on the screen, against a red background.
	Action required:	• Remove the patient from GALILEO and secure alternative ventilation. • Look in the alarm buffer and note the sequence of alarms present. (The alarm buffer is available during normal ventilation.) • Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch). **Note** If you are running Upgrade 2 test software, ***please send the event log to us***. This is described in Section 12.2.4, *How to send the event log to HAMILTON MEDICAL AG*, on page 12-58.

12.2.4 How to send the event log to HAMILTON MEDICAL AG

In event of a major technical failure (any technical failure between 5500 and 9999) HAMILTON MEDICAL AG request you send us a copy of the event log.

Note
You must be running GALILEO Upgrade 2 (version 3) software to do this.

Please follow this procedure:

1. Export the event log to a CompactFlash data carrier, as described in Unit 17.5, *Exporting the event log*, on page 10-100.
2. If you have a suitable CompactFlash reader, e-mail the recorded file **event.txt** to HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch)
3. If you cannot read the CompactFlash, send the CompactFlash card to:
   HAMILTON MEDICAL AG
   Repair Department
   Via Nova
   CH-7403 Rhäzuns
   Switzerland.
   HAMILTON MEDICAL AG will analyze the file, and instruct you accordingly.

12.3 Troubleshooting using LEDs

12.3.1 Control board LED troubleshooting

12.3.1.1 Introduction

Use this section only if there is no technical fault message displayed on the screen. Technical fault messages give more precision in analyzing faults than LEDs do. For more information, see Section 12.2, *Troubleshooting using technical faults*, on page 12-2.

In this section you analyze many problems by looking at the LEDs on the *control board* of Upgrade 2 GALILEOs. This section is particularly useful if you have just fitted a new Upgrade 2 control board (PN 155461).

Note
You cannot perform control board LED troubleshooting with original or Upgrade 1 GALILEOs.

12.3.1.2 Procedure

1. Open GALILEO's main enclosure, as described in Section 11.4, *Opening the main enclosure*, on page 11-4.
2. Identify the diagnostic LEDs on the control board. These are positioned as shown in Figure 12-1.

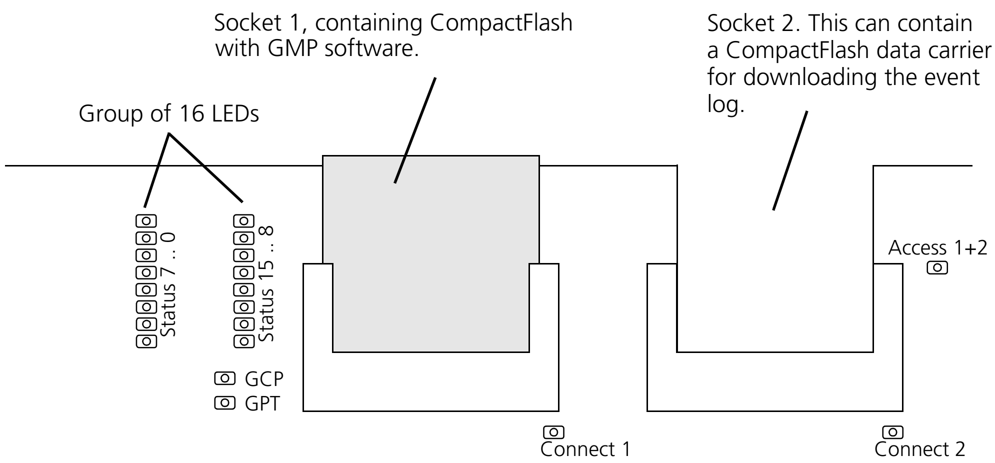


Figure 12-1. Positions of diagnostic LEDs on control board

The 16 LEDs numbered **Status 7 .. 0** and **Status 15 .. 8** are referred to as "the group of 16 LEDs" in this manual.

3. Use the following table to diagnose faults:

<table>
<tr><th colspan="2">Symptom</th><th>Meaning</th><th>Action</th></tr>
<tr><td colspan="2">The GCP LED is red (emergency status), but LCD display does not show a technical fault.</td><td>The GCP software is halted.
There is a hardware or cabling problem. Possibly a cable is missing, or is connected to the wrong board or module.</td><td>Make sure that all cables from the control board are correctly placed and properly connected.</td></tr>
<tr><td colspan="2">The GCP LED is red (emergency status) and the LCD display shows a technical fault of type TF 55xx.</td><td>The GCP software is not running. There is a technical fault.</td><td>Respond to the TF 55xx technical fault code according to the GALILEO Service Manual.
Note
One of the following technical faults can also be displayed:
TF 9421
TF 9907
If such a fault is displayed, it is because it is generated by the TF 55xx fault. It must disappear when the TF 55xx fault is solved. If it does not disappear, contact HAMILTON MEDICAL AG technical support.</td></tr>
<tr><td colspan="2">Status LED 15 (on the bottom right) flashes at one-second intervals.
The LCD display does not function.</td><td>The GMP is functioning. The problem is directly related to the LCD display.</td><td>WARNING
The dc/ac converter operates at approximately 1700 V.
• Make sure the cable from the GMP assembly to the LCD display is properly connected. (PN 155304.)
• Make sure the dc/ac converter is properly installed, with all cables connected.
• If the LCD display backlights are connected but do not light up, replace them. (Section 11.24.6, Replacing the LCD display and backlights, on page 11-127.)</td></tr>
<tr><td rowspan="2">The group of 16 LEDs is not flashing (check especially LED 15 on the bottom right).</td><td></td><td>The GMP software is not running. The software or operating system is not loaded and running.</td><td rowspan="2">• Check the green LED named Access 1+2. If it is permanently on, there is an IDE bus fault. Perform the actions for Symptom 10.
• Check the LEDs named Connect 1 and Connect 2. These LEDs confirm the status of the CompactFlash™ slot. Each LED must display red when the appropriate slot is occupied.
(The GMP program carrier is always in the left socket. The right slot might contain a GMP data carrier.)
If an LED does not display red when its slot is occupied, make sure the appropriate CompactFlash™ is properly seated.
If it is not possible to make an LED display red when its slot is occupied, contact HAMILTON MEDICAL AG technical support.</td></tr>
<tr><td>The LCD display does not show the GALILEO setup screen. (The self-test screen displays <code>Self-Test:</code> followed by a status bar.)</td><td>The loading of the operating system, or the GMP software failed.</td></tr>
</table>

There is an emergency alarm 40 seconds after switching on GALILEO Gold. The display does not show the setup screen. The green LED named **Access 1+2** (Figure 12-1 on page 12-59) is either always on, or always off.	The loading of the operating system and GMP software failed, because of an IDE bus failure.	• Make sure that the CompactFlash program carrier for the GMP is in the correct slot. This is the left slot, marked **1**. • Make sure that IDE cable (PN 155424) is properly connected. • Replace the cable.

12.3.2 Power supply board LED troubleshooting

12.3.2.1 Introduction

The following section explains how to use the LEDs on the power supply in the column for troubleshooting power supply problems.

Note
The power supply board LEDs indicate only that the power supply is functioning to some degree. They do not indicate that any voltage supplied is within specification.

12.3.2.2 Procedure

1. Open GALILEO’s column, as described in Section 11.5, *Opening the column*, on page 11-6.
2. Connect GALILEO to the mains power supply and switch it on using the switch on the rear panel.

WARNING
The open column now exposes you to mains voltages. Do not touch any item in the column while the mains power supply is connected.

3. Identify the troubleshooting LEDs, as shown in Figure 12-2 or Figure 12-3, and check that all light up.
   - LED 1: +5 V
   - LED 2: +15 V
   - LED 3: -15 V
   - LED 4: +12 V

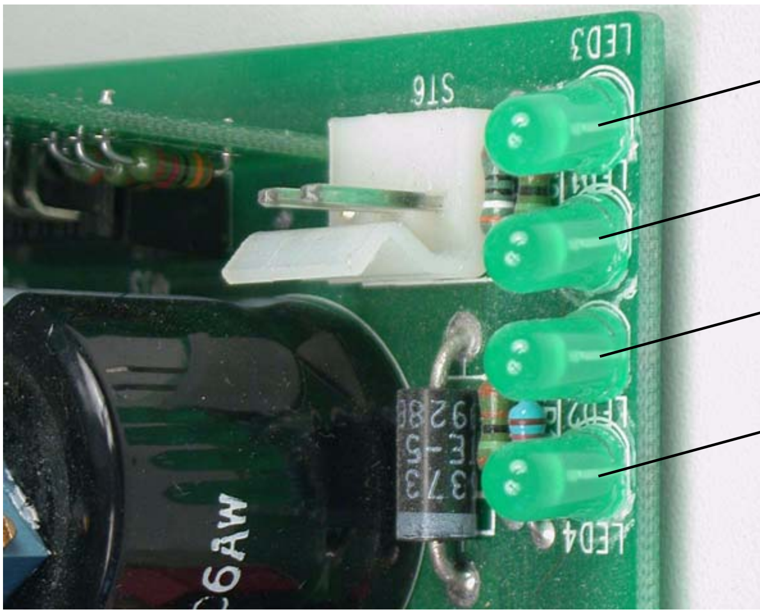


Figure 12-2. Troubleshooting LEDs on early power supply boards

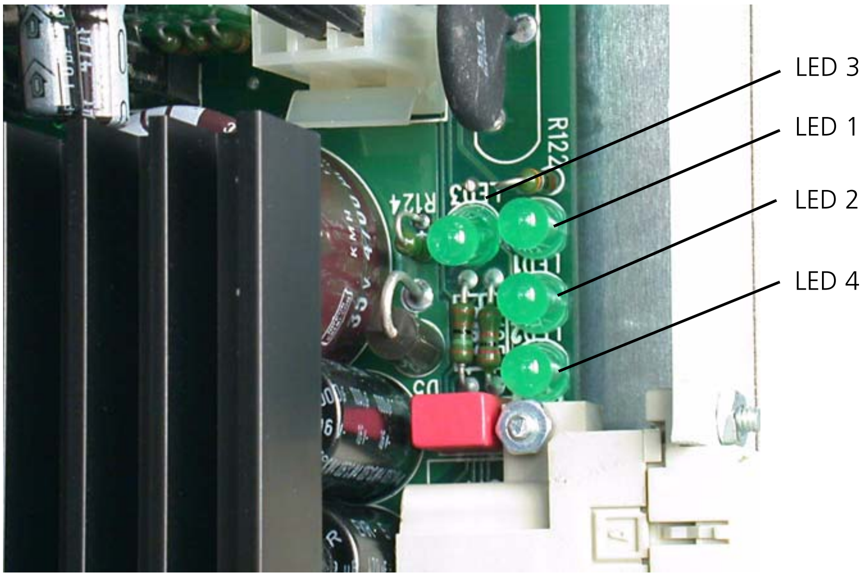


Figure 12-3. Troubleshooting LEDs on later power supply boards

4. Perform one of the following actions, depending on the status of the LEDs:

LED status	Comment	Action
One LED does not light up.	This indicates a problem in the voltage indicated by the failed LED. The problem could lie in the power supply. However, it could also lie somewhere else.	1. Switch off GALILEO, and disconnect it from the mains power supply. 2. Disconnect the large cable that distributes power from the power supply to the components in the enclosure. Disconnection is shown in Figure 11-200 on page 11-180 in Section 11.29.8, *Replacing the power supply*, on page 11-179. 3. Reconnect GALILEO to the mains power supply, and switch it on. • If the same LED fails to light up, the fault is very likely to be located on the power supply. Replace the power supply as documented in Section 11.29, *Power supply and fuses*, on page 11-176. • If the LED lights up, the problem is probably a short circuit in GALILEO, and not a failure on the power supply. Search for the cause of the short circuit.
All LEDs light up.	The power supply is probably, but not definitely functioning properly. The fault is probably a wiring disconnect or poor contact somewhere in GALILEO.	Search for the problem, starting with the large power cable shown in Figure 11-200 on page 11-180 in Section 11.29.8, *Replacing the power supply*.
None of the LEDs light up.	The problem is almost definitely in the power supply.	If none of the LEDs light up, replace the power supply as documented in Section 11.29, *Power supply and fuses*, on page 11-176.

Table 12-2. Responding to power supply LEDs

Note
If all the LEDs light up, it is nevertheless possible that the power supply is faulty.

12.3.3 Interface board LED troubleshooting

12.3.3.1 Introduction

The interface board has only one LED. This limits its usefulness for troubleshooting.

12.3.3.2 Characteristics

Action or Status	Correct LED behavior	Meaning
Mains power to GALILEO is switched on.	LED lights up very briefly and then goes dark.	• Power supply to LED is functioning normally, and voltage is in range.
GALILEO start-up sequences completes. (30 to 60 seconds after switching on.)	LED lights up and remains alight.	• Power supply to LED is functioning normally, and voltage is in range. • GIP software is recognized.
GALILEO is connected to a patient monitor by means of the RS232 interface.	LED lights up and goes dark frequently. (In other words, LED flickers on and off.)	• Transmission of data is taking place between GALILEO and the patient monitor.

Table 12-3. Responding to interface board LEDs

12.4 Troubleshooting using general symptoms

12.4.1 Introduction

Use this section to troubleshoot problems that do not display a technical fault and cannot be diagnosed using LEDs.

12.4.2 Procedure

Use the table below to perform troubleshooting:

<table>
<tr><th>Problem or problem area</th><th colspan="2">Details</th><th>Action</th></tr>
<tr><td rowspan="4">GALILEO does not start properly.</td><td colspan="2">When you switch on GALILEO, nothing happens.</td><td>• Verify the hospital power supply is working correctly.
• Check, and if necessary, replace one of the fuses. (Section 11.29, Power supply and fuses, on page 11-176.)
• Check, and if necessary, replace the power supply in GALILEO’s column. (See Section 12.3.2, Power supply board LED troubleshooting, on page 12-62 for checking, and Section 11.29, Power supply and fuses, on page 11-176 for replacement.)</td></tr>
<tr><td rowspan="3">When you switch on GALILEO, you hear a series of beeps, but GALILEO does not start. (The beeps are produced by the BIOS.)</td><td>1 beep</td><td>• No error indicated. No action required.</td></tr>
<tr><td>2 or 3 beeps</td><td>• Check the 3 V clock battery. (Section 7.3, Checking voltages, on page 7-3.) If you must replace this, check (and if necessary set) the date and time as described in the operators’ manual for your GALILEO.
• Reseat the memory chips.
• Replace the memory.</td></tr>
<tr><td>4 to 11 beeps</td><td>• Contact HAMILTON MEDICAL and give details of the beep sequence you hear, and the BIOS you have.</td></tr>
</table>

Table 12-4. General troubleshooting

Problem or problem area	Details		Action
GALILEO does not start properly (continued).	GALILEO begins to start, but stops on the blue **`HAMILTON MEDICAL Startup`** screen.	The startup screen is properly displayed.	• Verify the main ribbon cable to the GMP assembly is properly connected. • Replace the GMP CompactFlash program carrier. (Section 11.19.5, *Replacing the GMP CompactFlash*, on page 11-101.)
		The startup screen is not properly displayed, but has “snow” at the top, as shown in Figure 12-4 on page 12-68.	• Check your GMP hardware and software versions. If you have GMP CPU module PC_104 PN 396170, you must have software version GMP 03.13a or later software. (The software is held on the GMP CompactFlash data carrier.
LCD display is faulty.	The screen, although readable, is much darker than normal.		**WARNING** **The dc/ac converter operates at approximately 1700 V.** • Make sure the dc/ac converter is properly installed, with all cables connected. • Replace one or both of the LCD backlights. (Section 11.24.6, *Replacing the LCD display and backlights*, on page 11-127.)
	The screen shows a color shift or there is no color.		• Make sure the cable from the GMP assembly to the LCD display is properly connected. (PN 155304.)
	The screen does not light up at all. Otherwise, GALILEO appears to start as normal.		• Replace the LCD display. (Section 11.24.6, *Replacing the LCD display and backlights*, on page 11-127.)
There is a loud buzzing.	There is no signal from the GMP assembly to the alarm amplifier.		• Make sure the small ribbon cable connecting the *GMP* assembly to the control board is properly connected. (PN 155424.) • Replace the ribbon cable. • Replace the GMP assembly.
There is an emergency alarm 40 seconds after switching on GALILEO Gold. The display does not show the setup screen. The green LED named **Access 1+2** (Figure 12-1 on page 12-59) is either always on, or always off.	The loading of the operating system and GMP software failed, because of an IDE bus failure.		• Make sure that the CompactFlash program carrier for the GMP is in the correct slot. This is the left slot, marked **1**. • Make sure that IDE cable (PN 155424) is properly connected. • Replace the cable.

Table 12-4. General troubleshooting

Problem or problem area	Details	Action
The loudspeaker never gives alarms.	There is no signal either from, or to, the alarm amplifier, or there is no 12 V power to the alarm amplifier.	• Make sure the loudspeaker cable to the *control board* is properly connected. • Make sure the small ribbon cable connecting the *GMP* assembly to the *control board* is properly connected. (PN 155424.) • Make sure the small cable connecting the *connector board* and *control board* is properly connected. (PN 155428.)
The buzzer does not give alarms, or gives alarms of duration less than 120 s.	There is no battery backup system.	• Check the revision of the *connector board*. • Replace the connector board with the latest version if the installed board is Rev 05 or lower. **Note** HAMILTON MEDICAL AG recommends that you install a battery backup system.
Date and time are lost.	It is likely that the 3 V clock battery has failed.	Check the 3 V clock battery. (Section 7.3, *Checking voltages*, on page 7-3.) If you must replace this, check (and if necessary set) the date and time as described in the operators' manual for your GALILEO.

Table 12-4. General troubleshooting

Figure 12-4. Example of faulty Startup screen with "snow"

Part 4: Appendixes

Appendix

A Maintenance tools and test equipment

A.1 Overview

You require the standard tools, special tools, ESD protection and test equipment detailed in the following sections to carry out:

- The maintenance documented in Section 6, *Engineer preventive maintenance*.
- The tests included in Section 9, *Running Original or Upgrade 1 test software* or Section 10, *Running Upgrade 2 test software*
- The maintenance and replacements documented in Section 4, *Component details*

A.2 Standard tools

To perform basic maintenance on equipment from HAMILTON MEDICAL AG, you require a range of:

- Screwdrivers (both flat and cross-head)
- Metric spanners (wrenches)
- Metric hexagonal-drive (Allen) keys (wrenches)

A.3 Special tools

A.3.1 IC extractor tool

Although this manual does not document software changes, your job requires you to often change software. For this, you need an integrated-circuit extractor. You can purchase a suitable tool (PN 239040) from HAMILTON MEDICAL AG. (Figure A-1.)

Figure A-1. PN 239040 integrated circuit extractor

A.3.2 Potentiometer adjustment tool

To adjust potentiometers while running test software, you can use a small screwdriver. However, the ideal tool is PN R70031. You can purchase this from HAMILTON MEDICAL AG. (Figure A-2.)

Figure A-2. PN R70031 tool for adjusting potentiometers

A.3.3 Multi-meter

To perform the tests in Section 8.3, *Electrical tests*, on page 8-4, and also Unit 8.4, *Performing the dP mixer zero calibration*, on page 10-39 (or TSW 8.4, *Performing the dP mixer zero calibration*, on page 9-32) you require a multi-meter capable of measuring resistance to a tolerance of ≤1 Ω (less than 1 Ohm).

A.3.4 Metron EST tester

Although not required by HAMILTON MEDICAL AG, some countries and some hospitals require that you perform the tests described in Section G, *Automated electrical safety tests*. For this, you require a Metron Safety Analyzer, or similar equipment.

Figure A-3. The Metron Safety Analyzer

A.3.5 ESD protection

You must have equipment for preventing damage caused by electrostatic discharge (ESD). Typically, this comprises:

- ESD grounding (earthing) cable and wrist band connected to the GALILEO for use when you are working on the GALILEO
- EDS grounding cable and wrist band connected to the work surface for use when you are working on an electronic component from the GALILEO

Figure A-4 shows a wrist band and connecting cable complete with the crocodile clip that must be attached to the ventilator or work surface.

Figure A-4. ESD band and cable

A.3.6 Test equipment

You require the following equipment, as well as the tools listed above, to carry out the tests and calibrations included in Section 9, *Running Original or Upgrade 1 test software* or Section 10, *Running Upgrade 2 test software*.

Pictures and details of most of these items are in the *Product Catalog*.

Item		Comment
	Capillary tube with 20 ml/s flow.	PN 500280.
	Orifice tube with 500 ml/s flow.	PN 500290.

Item	Comment
 Pressure connector.	PN 500300.
 Microflow and pressure regulator (also referred to as a flow restrictor).	For example, PN 500335.
 Hand pump.	For example, PN 500330.
 Pressure gauge with the following specifications: • Range: 0–25 mbar Accuracy: ≤ 0.5% • Range: 0–400 mbar Accuracy: ≤ 0.5% • Range: 0–10 bar Accuracy: ≤ 0.5%	Suitable gauges are manufactured by THOMMEN (www.thommenag.ch) and WIKA (www.wika.com). One gauge from WIKA can be obtained from HAMILTON MEDICAL, PN 500058.
 T-piece, external pressure, 4-5 mm OD connector.	PN 279199.
 Tube, silicone, 4 mm ID, 7 mm OD. Order by the mm.	PN 7249057.
 Preformatted CompactFlash card to download eventlog.	PN 155537.

Item		Comment
	Stopper for use in creating equipment setups when performing test software.	A suitable yellow stopper is supplied with every GALILEO delivered. Apart from this, stoppers are not provided by HAMILTON MEDICAL AG.
	Bacteria filter.	PN 279211.
	Proprietary locking paint or sealer. Alternatively, nail polish.	For locking potentiometer setting screws in place after adjustment.

A.3.6.1 Care of test equipment

Some test equipment must itself be tested and recalibrated periodically. HAMILTON MEDICAL recommends the following schedule:

Item	Schedule	Action
Pressure gauge	As recommended by the manufacturer, or at least once per year.	Send the pressure gauge back to the manufacturer for testing. You can usually find a convenient address by looking on the appropriate website (for example, www.thommenag.ch or www.wika.com).
Multi-meter	As recommended by manufacturer.	As recommended by manufacturer.
20 ml/s capillary tube	Every year.	Send the tube back to HAMILTON MEDICAL for checking.
500 ml/s orifice tube	Every year.	Send the tube back to HAMILTON MEDICAL for checking.

Appendix

B Communication interface specifications

B.1 Introduction

This appendix describes the two ports on the communication interface, namely:

- The RS232 port.
- The Special port.

The structure of this section is outlined in the table below:

Feature	RS232 port	Special port
Functions of port	• Appendix B.2.2, *Sending data to a patient monitor*, on page B-1. • Appendix B.2.3, *Sending data to a computer*, on page B-4.	• Appendix B.3.2, *Sending inspiratory:expiratory (I:E) timing signals*, on page B-7. • Appendix B.3.3, *Sending a remote nurse alarm*, on page B-8.
Pin locations of port	• Appendix B.2.4, *RS232 pin locations and assignments*, on page B-5	• Appendix B.3.4, *Special interface pin locations and assignments*, on page B-9.
Pin assignments of port	• Appendix B.2.4, *RS232 pin locations and assignments*, on page B-5.	• Appendix B.3.4, *Special interface pin locations and assignments*, on page B-9.
Protocols of port	Limited information only given here: • Appendix B.2.5, *HAMILTON MEDICAL RS232 low-level data transmission protocol*, on page B-6.	Not described.

Table B-1. Contents of this appendix

For programming purposes, you require the document *External Communication Hamilton Ventilator RS232 Protocol*. For more information, contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

B.2 RS232 interface

B.2.1 Overview

The RS232 interface enables the GALILEO to send monitored patient-data and waveforms, ventilation modes, control settings, and alarms to a patient monitor or a computer.

Table B-4, *RS232 interface connector pin assignments*, on page B-5 lists the pin assignments for the RS232 connector.

B.2.2 Sending data to a patient monitor

The GALILEO RS232 interface supports Philips, Spacelabs, and Marquette patient monitors, in addition to HAMILTON MEDICAL's Leonardo.

WARNING

Not all monitors provide detailed alarm messages. For more information, see Table B-6, *Alarm behavior with third party monitoring systems*.

Using the GALILEO with a patient monitor requires the hardware shown in Figure B-1. Suitable interfacing hardware, specific to the manufacturers' monitors, is listed in Table B-2. This hardware must be ordered directly from the monitor manufacturer.

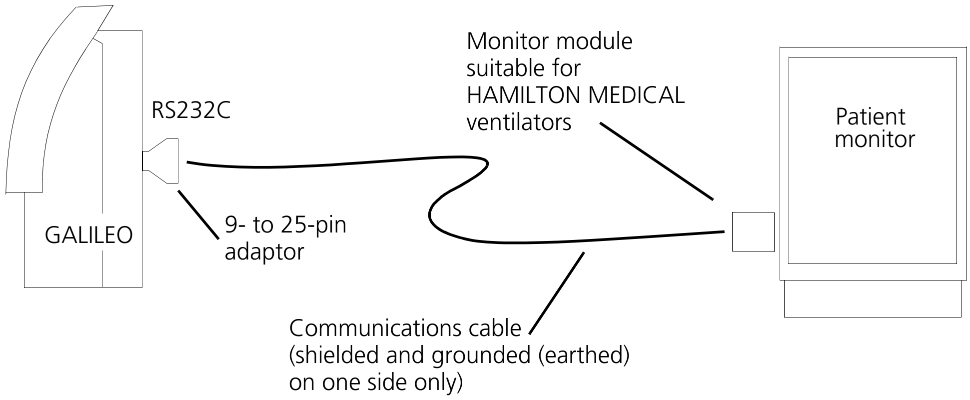


Figure B-1. GALILEO connected to a patient monitor

Manufacturer	Interfacing hardware required	Notes
SpaceLabs	Flexport and cable for HAMILTON MEDICAL ventilators.	
Marquette	Octanet and cable for HAMILTON MEDICAL ventilators.	Tram-net does not work.
Philips	• If using a Philips module with *VueLink driver for HAMILTON MEDICAL Ventilators* Release AA: HAMILTON VENTILATOR cable from Philips. • If using a Philips module with *VueLink Open* driver: OPEN INTERFACE cable from Philips.	For more details, see Appendix B.2.2.1, *Details of sending data to Philips patient monitors*, on page B-2.

Table B-2. Interfacing hardware for patient monitors

B.2.2.1 Details of sending data to Philips patient monitors

Overview

When using GIP interface software revision 01.20 (or 01.10), the GALILEO RS232 port automatically selects either HAMILTON MEDICAL's own proprietary communications protocol, or Philips' VueLink Open protocol, according to the device to which it is connected.

However, there are limitations when using Philips patient monitors:

- The ***original driver*** in the Philips VueLink module (VueLink driver for HAMILTON Ventilators, release AA) ***is compatible with GIP 1.00, GIP 1.01, and GIP 1.10*** interface software.
- The ***original driver is not compatible with GIP 1.20***.
- The ***new driver*** in the Philips VueLink module (the VueLink Open driver) ***is compatible with GIP 1.10 and GIP 1.20***.

Details

The following table gives a complete overview:

		GIP 01.00 PN 155366[a]	GIP 01.01 PN 155606[a]	GIP 01.10 PN 155582[b]	GIP 1.20 PN 155586
	Contains HAMILTON MEDICAL proprietary protocol	Yes	Yes	Yes	Yes
	Contains Philips VueLink Open protocol	No	No	Yes	Yes
	Exp Min Vol format used	xx.xx	xx.xx	xx.xx	x.xxx[c]
Philips patient monitor module with *VueLink driver for HAMILTON MEDICAL Ventilators*, Release AA	**Operates with Philips module and *VueLink driver for HAMILTON MEDICAL Ventilators* Release AA**	Yes	Yes	Yes	No
	Protocol used	HAMILTON MEDICAL proprietary	HAMILTON MEDICAL proprietary	HAMILTON MEDICAL proprietary	N/A
	Cable required	HAMILTON MEDICAL	HAMILTON MEDICAL	HAMILTON MEDICAL	N/A
	Adaptor required	RS232 9-to-24 pin, male PN 396154	RS232 9-to-24 pin, male PN 396154	RS232 9-to-24 pin, male PN 396154	N/A
Philips patient monitor module with VueLink Open driver	**Operates with Philips module and *VueLink Open* driver**	No	No	Yes	Yes
	Protocol used	N/A	N/A	VueLink Open	VueLink Open
	Cable required	N/A	N/A	OPEN INTERFACE	OPEN INTERFACE
	Adaptor required	N/A	N/A	RS232 9-to-24 pin, female PN 396129	RS232 9-to-24 pin, female PN 396129

Table B-3. GIP and Philips compatibility

a. No longer available.
b. Still available at time of writing. (August 2005.)
c. Format changed from earlier versions, to give more resolution for pediatrics.

B.2.3 Sending data to a computer

The RS232 interface also enables you to send data to a computer, so that the data can be manipulated using software such as Microsoft Excel. This is useful for data management and clinical studies.

WARNING

Any computer connected to the GALILEO must be for medical use, and must meet the requirements of IEC 60601-1. Do not connect an ordinary personal computer, because such computers do not fulfill the requirements of the standard. Consult a technical specialist or safety inspector in your hospital for more information.

Sending data requires the hardware shown in Figure B-2. It also requires the GALILEO Data Logger software and manual, which can be downloaded from the HAMILTON MEDICAL website, in the “Science” section (www.hamilton-medical.com).

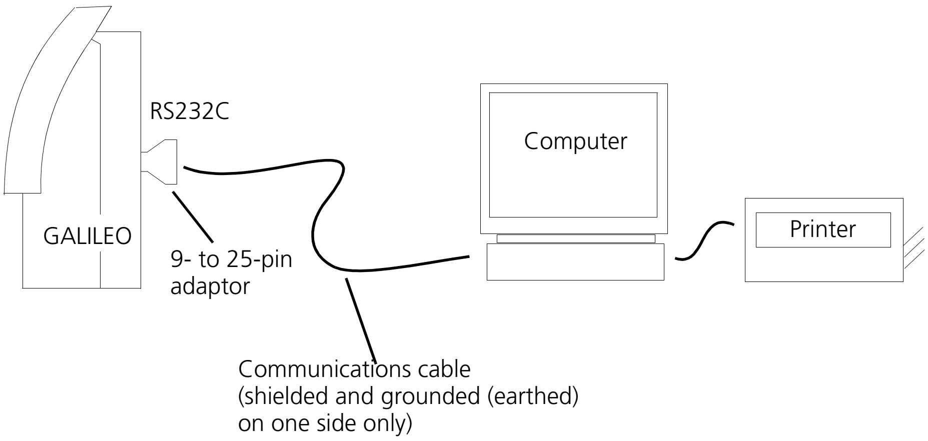


Figure B-2. GALILEO connected to a computer

B.2.4 RS232 pin locations and assignments

Figure B-3 shows the locations of the RS232 interface connector pins. Table B-4 lists the pin assignments.

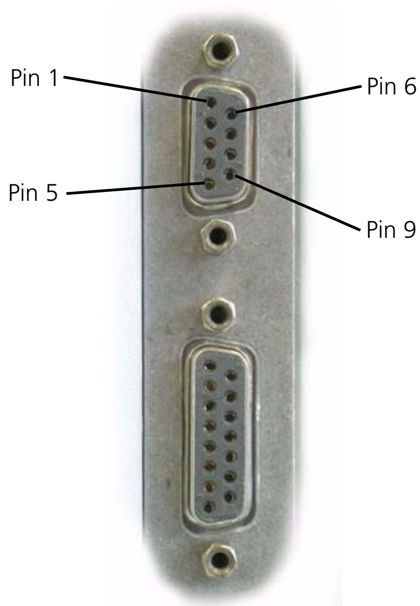


Figure B-3. RS232 interface connector pin locations

RS232 connector	
Pin	**Signal**
1	GND
2	RXD
3	TXD
4	DTR
5	GND (signal ground)
6	DSR
7	RTS
8	CTS
9	--
Shield	Chassis ground

Table B-4. RS232 interface connector pin assignments

B.2.5 HAMILTON MEDICAL RS232 low-level data transmission protocol

Parameter	Value
Baud rate	9600
Data bit	7
Stop bit	2
Parity	Even
Handshake	XON/XOFF

Table B-5. HAMILTON MEDICAL RS232 data transmission protocol

B.2.6 Alarm behavior with third party monitoring systems

Note

The GALILEO column displays the kind of alarm output by GALILEO. It does not necessarily display the alarm shown on the GALILEO display. The reason for this is that there are a limited number of identifiers available for GALILEO to output alarms, and so several internal alarms must sometimes share one external alarm identifier.

WARNING

The table below shows the results of research carried out by HAMILTON MEDICAL AG. Please note:

- **Because companies can change equipment specifications at any time, HAMILTON MEDICAL AG can take no responsibility for the accuracy of the information included.**
- **Because an increasing number of companies are confirming their equipment is compatible with the GALILEO ventilator, the table is not exhaustive.**

GALILEO		Leonardo	Marquette	Philips	Space Labs	
Description	Possible screen message				Visual indication	Audible indication
	`General Alarm`	`General Alarm`	`ALARM` (blinks red)	`VENT FAILURE`[a] `VENT FAILURE`[b]	`Alarmgrenzverstos` `VENT - GENERAL ALARM`	Beep every 3 to 10 s
	`High Pressure`	`High Pressure`	`ALARM` (blinks red)	`HIGH AIRWAY PRES`[a] `HIGH PRESSURE`[b]	`VENT` (blinks) Alarm bell symbol blinks PEEP bell symbol blinks	Continuous tone
	`Disconnection Patient`	`Disconnection`	`ALARM` (blinks red)	`PAT. DISCONNECT`[a] `PAT DISCONNECT`[b]	`Alarmgrenzverstos`	Beep every 3 to 10 s
	`Fail to Cycle`	`Apnea` `Fail to Cycle`	`ALARM` (blinks red)	`FAIL TO CYCLE`[a]	`Alarmgrenzverstos`	Beep every 3 to 10 s
	`Apnea`	`Apnea` `Fail to Cycle`	`ALARM` (blinks red)	`APNEA`[a] `APNEA`[b]	`Alarmgrenzverstos`	Beep every 3 to 10 s

Table B-6. Alarm behavior with third party monitoring systems

GALILEO		Leonardo	Marquette	Philips	Space Labs	
Description	Possible screen message				Visual indication	Audible indication
	Disconnection	Disconnection	ALARM (blinks red)	VENT DISCONNECT[a] VENT DISCONNECT[b]	Alarmgrenzverstos	Beep every 3 to 10 s
	Loss of PEEP	Loss of PEEP	ALARM (blinks red)	LOW PEEP[a] LOW PEEP[b]	VENT (blinks) Alarm bell symbol blinks PIP bell symbol blinks	Continuous tone
	Low Min Vol	Exp. Minute Vol	ALARM (blinks red)	LOW MIN VOL[a] LOW MIN VOL[b]	VENT (blinks) Alarm bell symbol blinks Vmin bell symbol blinks	Continuous tone
	High Min Vol	Exp. Minute Vol	ALARM (blinks red)	HIGH MIN VOL[a] HIGH MIN VOL[b]	VENT (blinks) Alarm bell symbol blinks Vmin bell symbol blinks	Continuous tone
	High Rate	High Rate	ALARM (blinks red)	HIGH RESP RATE[a] HIGH RESP RATE[b]	VENT (blinks) Alarm bell symbol blinks Vmin bell symbol blinks	Continuous tone
	Oxygen Concentration	Oxygen Concentration	ALARM (blinks red)	LOW/HIGH FIO2[a] LOW/HIGH FIO2[b]	VENT (blinks) Alarm bell symbol blinks FIO2 bell symbol blinks	Continuous tone
	Operator	Flowsensor / User	ALARM (blinks red)	VENT CHK ADJUSTMENT[a] VENT CHK ADJUSTMENT[b]	Alarmgrenzverstos	Beep every 3 to 10 s
	Gas Supply	Gas Supply	ALARM (blinks red)	GAS SUPPLY DOWN[a] GAS SUPPLY DOWN[b]	VENT (blinks) Alarm bell symbol blinks PIP bell symbol blinks Alarmgrenzverstos VENT - GAS SUPPLY VENT - GENERAL ALARM	Continuous tone
	GALILEO switch off	No reaction. Previous values displayed.	CONNECT CABLE VENT OFF (blinks)	VENT CHECK SETUP[a] VENT CHECK SETUP[b]	COMMUNICATION LINK LOST	Beep every 3 to 10 s

Table B-6. Alarm behavior with third party monitoring systems

a. VueLink driver for HAMILTON ventilators.
b. VueLink Open driver, English text.

B.3 Special interface

B.3.1 Overview

The 15-pin Special interface can be used to send inspiratory:expiratory timing signals for administering nitric oxide or for controlling an external nebulizer. It can also be used for activating a remote nurse alarm.

Table B-7, *Special interface connector pin assignments*, on page B-10 lists the pin assignments for this connector.

B.3.2 Sending inspiratory:expiratory (I:E) timing signals

To use inspiratory:expiratory timing signals for administering nitric oxide or for controlling an external nebulizer, you must first configure the Special interface according to the requirements of

your equipment. Details for configuration are given in Appendix B.4, *Configuring a GALILEO for a new communication interface*, on page B-10, especially in Table B-9, *Special interface configuration settings*.

In addition, you must fit the hardware shown in Figure B-4.

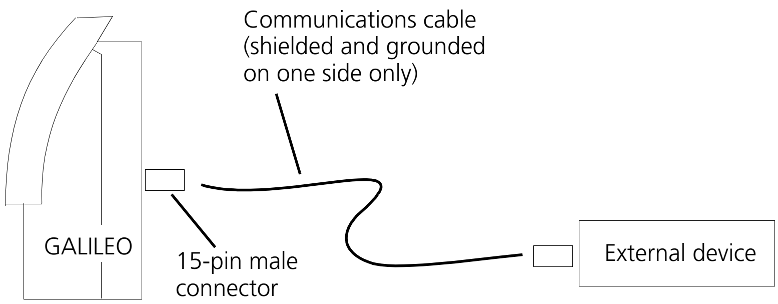


Figure B-4. GALILEO connected to an external device through the Special connector

B.3.3 Sending a remote nurse alarm

The remote alarm (nurse's call) capability allows alarm conditions to be indicated at locations away from the ventilator (for example, when the ventilator is in an isolation room).

The remote alarm capability is based on a relay inside the GALILEO. Figure B-5 shows the non-alarm and alarm positions for the relay. You can use either pins 7 and 14, or pins 7 and 6, depending on the logic of your nurse call system.

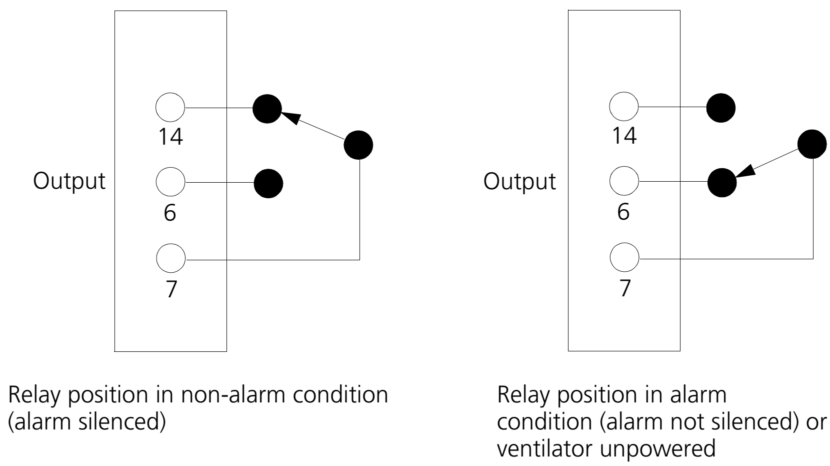


Figure B-5. Remote alarm relay positions

Note

The GALILEO alarm silence key silences the audible portions of the alarms at both the ventilator and the remote alarm device.

B.3.4 Special interface pin locations and assignments

Figure B-6 shows the locations of the special interface connector pins. Table B-7 lists the pin assignments.

CAUTION

Do not use any of the undescribed pins of the Special interface.

CAUTION

The maximum allowable voltage and current between the relay contacts is 48 V and 0.5 A.

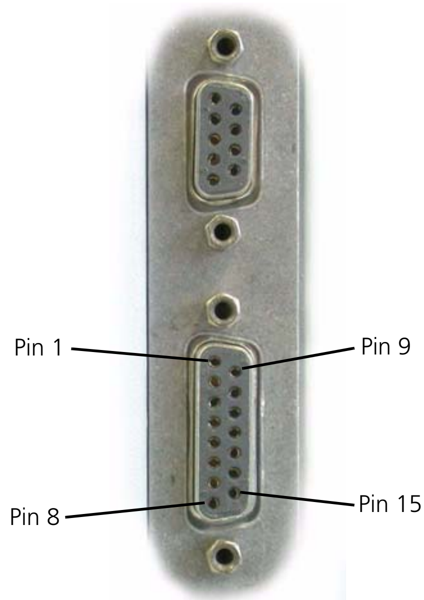


Figure B-6. Special interface connector pin locations

Special connector	
Pin	**Signal**
1	--
2	--
3	--
4	--
5	--
6	Remote alarm return (normally closed)
7	Remote alarm return (normally open)
8	I:E relay
9	--
10	--
11	--
12	--
13	--
14	Remote alarm return (normally open)
15	I:E relay return

Table B-7. Special interface connector pin assignments

B.3.5 Electrical specification of Special connection

Parameter	Value
Maximum voltage between relay contacts	48 V
Maximum current through relay contacts	0.5 A

Table B-8. Electrical specification of the Special connection

B.4 Configuring a GALILEO for a new communication interface

B.4.1 Introduction

If you have added the new interface to a GALILEO, and presuming you want to use it immediately, you must now configure the GALILEO to recognize it.

Ideally, you have a written record of the GALILEO's complete configuration, and you add to this original record the details of the interface configuration changes you now make.

B.4.2 The configuration procedure

1. Switch on the GALILEO, while at the same time holding down both the **MANUAL** and the **100% O2** keys for 5 seconds. Wait for the HAMILTON MEDICAL setup screen to display. (Figure B-7 shows the GALILEO Gold setup screen. Your screen must be very similar or identical to this.)

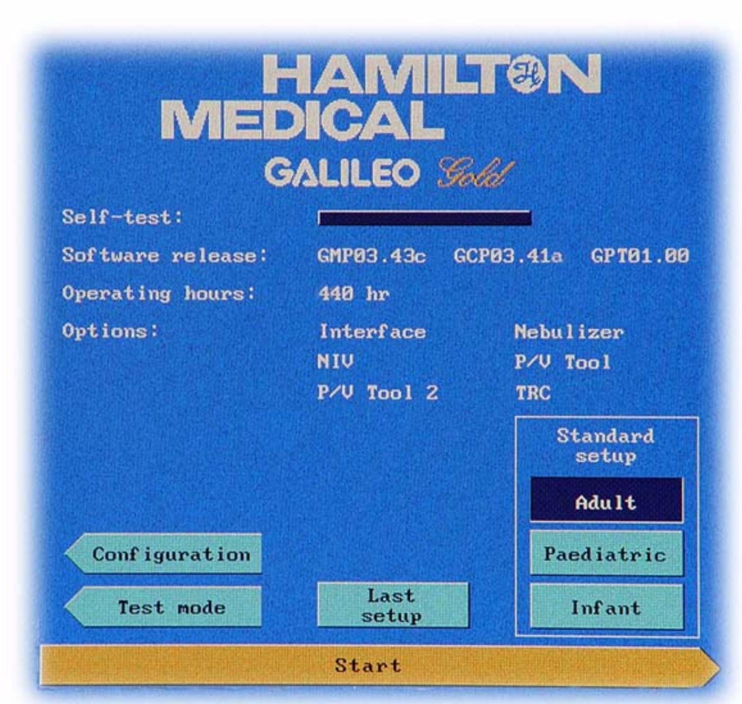


Figure B-7. The GALILEO Gold setup screen (you might not have the Gold version of GALILEO)

2. Activate the **`Configuration`** button on the setup screen. The **`Configuration`** menu opens. (Figure B-8.)

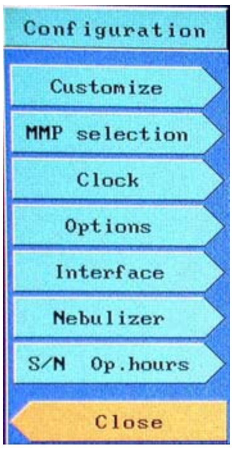


Figure B-8. The Configuration menu

3. Activate the new communication interface. To do this:
   a. Activate **`Options`** in the **`Configuration`** menu.
   b. In the **`Options`** window, set the **`Interface`** to **`On`**.
   c. Activate **`Close`**.
4. Configure the new communication interface. To do this:
   a. Activate **`Interface`** in the **`Configuration`** menu.
   b. Set all three **`I:E Outlet`** parameters as required by your hospital. These settings define the behavior of the Special (analog) interface when it is used to control an external nebulizer. Table B-9 gives an overview of the functions.

Parameter	Relay contact position	
	Open	Closed
Insufflation	Causes the relay contacts to open during the insufflation phase of inspiration.	Causes the relay contacts to close during the insufflation phase of inspiration.
Pause	Causes the relay contacts to open during the pause between inspiration and exhalation.	Causes the relay contacts to close during the pause between inspiration and exhalation.
Expiration	Causes the relay contacts to open during exhalation.	Causes the relay contacts to close during exhalation.

Table B-9. Special interface configuration settings

   For information about pin locations and assignments, see Appendix B.3.4, *Special interface pin locations and assignments*.
   c. Activate **`Close`** on the **`Interface`** menu, and then again on the **`Configuration`** menu, to return to the HAMILTON MEDICAL setup screen. (Figure B-7.)
5. Activate **`Start`**. The GALILEO stores your settings, and starts in normal operating mode.
6. Turn off the GALILEO.

Appendix

C GMP software/hardware compatibility

C.1 Introduction

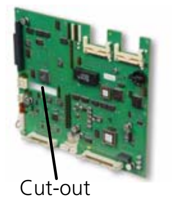
This section deals with GMP software/hardware compatibility inside the GALILEO ventilator. It does not deal with software/software compatibility in GALILEO: you can find out more about this in Appendix D, *Software revisions, features and compatibility*. Furthermore, it does not deal with compatibility between GALILEO and connected devices. Sections that deal with connected devices are:

- Appendix B.2.2, *Sending data to a patient monitor*
- Appendix B.2.3, *Sending data to a computer*
- Appendix B.3.2, *Sending inspiratory:expiratory (I:E) timing signals*
- Appendix B.3.3, *Sending a remote nurse alarm*

C.2 GMP software and GALILEO hardware compatibility

The following table shows compatibility across all GALILEOs with respect to GMP software, GMP hardware, and the control board.

Note
GMP software must always match other software in GALILEO, as documented in Appendix D.3, *General rules for software compatibility*, on page D-2.

<table>
<tr><th></th><th colspan="2">PN 155154</th><th colspan="2">PN 155461</th></tr>
<tr><th></th><th>GALILEO</th><th>GALILEO “silver”</th><th colspan="2">Classic GALILEO
or
GALILEO Gold</th></tr>
<tr><td>Serial number</td><td>SN 1001 to 1838</td><td>SN 1839 to 3999</td><td colspan="2">SN 4001 on</td></tr>
<tr><td>Upgrade version</td><td>Original</td><td>Software version 2
(Upgrade 1)</td><td colspan="2">Software version 3
(Upgrade 2)</td></tr>
<tr><td>GMP software</td><td>• GMP 01.*</td><td>• GMP 02.*</td><td>• GMP 03.1* Classic
• GMP 03.3* Classic
• GMP 03.1* USAclassic
• GMP 03.3* USAclassic
• GMP 03.1* Gold
• GMP 03.3* Gold</td><td>• GMP 03.13* Classic[a]
• GMP 03.3* Classic[a]
• GMP 03.13* USAclassic[a]
• GMP 03.3* USAclassic[a]
• GMP 03.13* Gold[a]
• GMP 03.3* Gold[a]</td></tr>
<tr><td>Control board</td><td colspan="2">PN 155154
</td><td>PN 155461
Rev 00 to 03

Cut-out</td><td>PN 155461
Rev 04 and later

Cable</td></tr>
<tr><td>GMP hardware</td><td>PN 396138
</td><td>PN 155460
</td><td>PN 155499

For control board PN 155461 Rev 00 to 03, and for early versions of control board PN 155461 Rev 04.</td><td>PN 396170

PN 155563

For later versions of control board PN 155461 Rev 04, and later.</td></tr>
</table>

Table C-1. GMP software and GALILEO hardware compatibility

a. Control board PN 155461 Rev 04 and later requires GMP 03.13* and later. Earlier revision boards can use GMP 03.1*.

Appendix

D Software revisions, features and compatibility

Note
To view and print the latest version of this appendix, go to the HAMILTON MEDICAL AG Partner Web Site (http://www.hamilton-medical.com/partner-site) and click on *Updates & Upgrades*. You can also find information about upgrading and updating GALILEO in this part of the web site.

D.1 Introduction

This appendix gives an overview of all published GALILEO software. It includes information about new features introduced with software upgrades, and information about compatibility between software of different versions.

With one exception, only the latest software versions are available for order from HAMILTON MEDICAL AG at any time. The exception is GIP 01.10 (the latest version is GIP 01.20). The reason for this is that GIP 01.20 can only interface with VueLink Open (not VueLink).

In the tables in this appendix, all current software is printed in **bold**.

D.2 Definitions

Note
The software version of a GALILEO is defined by its *GMP* (GALILEO Main Processor) software. All other software included in the GALILEO (*GCP*, *GIP*, and *GPT*) must be compatible with the GMP software.

GMP software — Software used by the GALILEO Main Processor. The software is contained on the GMP software CompactFlash.

In original and Upgrade 1 GALILEOs, the CompactFlash and the GMP processor are part of the same assembly. In Upgrade 2 GALILEOs (SN 4000 and higher), the CompactFlash card is mounted on the control board.

GCP software — Software used by the GALILEO Control Processor. This software is contained on a PROM positioned on the control board.

GIP software — Software used by the GALILEO Interface Processor. This software is contained on an EPROM positioned on the interface board, if the interface board is fitted.

GPT — GALILEO Press-&-Turn controller. A microcontroller with on-chip ROM and RAM that manages the control and the monitoring press-&-turn knobs, and the four keys on the front panel. The GPT is mounted on the control board.

D.3 General rules for software compatibility

D.3.1 Introduction

GMP and GCP software must always match for GALILEO operate correctly. However, GIP and GPT compatibility is not critical, as very few changes have been made to these EPROMs. In practice, therefore, you must only check the GMP and GCP revisions.

D.3.2 Checking compatibility

Software versions and revisions are displayed on the setup screen. Figure D-1 shows the GALILEO Gold setup screen. Your screen must be similar, but not necessarily identical.

Figure D-1. The GALILEO Gold setup screen

GMP*ww.xyz* must match GCP*ww.xyz,* where:

- *ww* = software version, and is always 03 for GALILEO Gold and GALILEO classic
- *xy* = software revision (updates or bug fixes within the same generation), where:
  - *x* = any numeral ("1" in the first release), represents a major revision, and is relevant for compatibility
  - *y* = any numeral, represents a minor revision, and is not relevant for compatibility
- z = any letter, represents the software build, and is not relevant for compatibility

For example:

- Matching software could be: GMP03.10a and GCP03.11b
- Non-matching software could be: GMP03.03c and GMP03.10a

D.4 Software version 1

Note
The latest software versions are printed in **bold**.

GALILEO model	GALILEO "basic" (USA and non-USA)			
Date	From 1997.			
Part Numbers	**GMP software version**	**GCP software version**	**GIP software version**	**GPT version**
	GMP 01.06 PN 155326	GCP 01.02 PN 155328	GIP 01.00 PN 155366 also GIP 01.01 PN 155606 **also GIP 01.10 PN 155582** **also GIP 01.20 PN 155586**[a]	**GPT 01.00 PN 155327**
	GMP 01.14c PN 155344	GCP 01.123 PN 155345 GCP 01.124 PN 155348		
	GMP 01.20f PN 155349 GMP 01.21b PN 155356 **GMP 01.22a PN 155358**	**GCP 01.202 PN 1455351**		

Table D-1. Software version 1

a. GIP 01.20 does not function with patient monitors that do not support the VueLink Open protocol, for example, Philips monitors using the driver called *VueLink driver for HAMILTON Ventilators*, release AA.

D.5 Software version 2 (Upgrade 1)

Note
The latest software versions are printed in **bold**.

GALILEO model	GALILEO "silver" (USA and non-USA)			
Date	From February, 2000.			
Part Numbers	**GMP software version**	**GCP software version**	**GIP software version**	**GPT version**
	GMP 02.10c PN 155405 GMP 02.11a PN 155408 **GMP 02.12a PN 155507**	**GCP 02.10a PN 155406**	GIP 01.00 PN 155366 GIP 01.01 PN 155606 **GIP 01.10 PN 155582** **GIP 01.20 PN 155586**[a]	**GPT 01.00 PN 155327**
Additional features	• Neonatal support • Battery backup provided as standard • Communication interface option • ASV graphics window • Trending • Freeze and cursor • WOB improvement • Programmable MMP			

Table D-2. Software version 2

a. GIP 01.20 does not function with patient monitors that do not support the VueLink Open protocol, for example, Philips monitors using the driver called *VueLink driver for HAMILTON Ventilators*, release AA.

D.6 Software version 3 (Upgrade 2)

Note
The latest software versions are printed in **bold**.

<table>
<tr><th>GALILEO models</th><td colspan="4">Classic GALILEO
Classic GALILEO, USA version
GALILEO Gold
GALILEO Gold, USA version</td></tr>
<tr><th>Date</th><td colspan="4">From April, 2002.</td></tr>
<tr><th rowspan="4">Part Numbers, classic GALILEO</th><th>GMP software version</th><th>GCP software version</th><th>GIP software version</th><th>GPT version</th></tr>
<tr><td>GMP 03.10c Classic PN 155535
GMP 03.11a Classic PN 155544
GMP 03.12b Classic PN 155555
GMP 03.13a Classic PN 155572</td><td>GCP 03.10d PN 155538
GCP 03.11a PN 155547
GCP 03.12a PN 155604</td><td rowspan="2">GIP 01.00 PN 155366
GIP 01.01 PN 155606</td><td rowspan="3">GPT 01.00 PN 155539</td></tr>
<tr><td>GMP 03.31c Classic PN 155575</td><td>GCP 03.31a PN 155578</td></tr>
<tr><td>GMP 03.41f Classic PN 155594
GMP 03.43cf Classic PN 155707</td><td>GCP 03.40a PN 155599
GCP 03.41a PN 155712</td><td>GIP 01.10 PN 155582
GIP 01.20 PN 155586[a]</td></tr>
<tr><th rowspan="5">Part Numbers, classic GALILEO, USA version</th><th>GMP software version</th><th>GCP software version</th><th>GIP software version</th><th>GPT version</th></tr>
<tr><td>GMP 03.10c USclassic PN 155536
GMP 03.11a USclassic PN 155546
GMP 03.12b USclassic PN 155556
GMP 03.13a USclassic PN 155573</td><td>GCP 03.10d PN 155538
GCP 03.11a PN 155547
GCP 03.12a PN 155604</td><td rowspan="2">GIP 01.00 PN 155366
GIP 01.01 PN 155606</td><td rowspan="4">GPT 01.00 PN 155539</td></tr>
<tr><td>GMP 03.31c USClassic PN 155576</td><td>GCP 03.31a PN 155578</td></tr>
<tr><td>GMP 03.41f USClassic PN 155595</td><td>GCP 03.40a PN 155599</td><td rowspan="2">GIP 01.10 PN 155582
GIP 01.20 PN 155586[a]</td></tr>
<tr><td>GMP 03.43c USClassic PN 155708</td><td>GCP 03.41a PN 155712</td></tr>
</table>

Table D-3. Software version 3

<table>
<tr><td rowspan="5">Part Numbers, GALILEO Gold</td><td>GMP software version</td><td>GCP software version</td><td>GIP software version</td><td>GPT version</td></tr>
<tr><td>GMP 03.10c Gold PN 155534
GMP 03.11a Gold PN 155545
GMP 03.12b Gold PN 155554
GMP 03.13a Gold PN 155571</td><td>GCP 03.10d PN 155538
GCP 03.11a PN 155547
GCP 03.12a PN 155604</td><td rowspan="2">GIP 01.00 PN 155366
GIP 01.01 PN 155606</td><td rowspan="4">GPT 01.00 PN 155539</td></tr>
<tr><td>GMP 03.31c Gold
PN 155574</td><td>GCP 03.31a PN 155178</td></tr>
<tr><td>GMP 03.41f Gold
PN 155593</td><td>GCP 03.40a PN 155599</td><td rowspan="2">GIP 01.10 PN 155582
GIP 01.20 PN 155586[a]</td></tr>
<tr><td>GMP 03.43c Gold
PN 155706</td><td>GCP 03.41a PN 155712</td></tr>
<tr><td>Additional features</td><td colspan="4">• Duo PAP and APRV
• NIV (GALILEO Gold only)
• Smart apnea backup
• New standby mode
• P/V tool (GALILEO Gold only)
• Event log
• Adjustable alarm volume
• TRC (GALILEO Gold only)</td></tr>
<tr><td rowspan="3">Part Numbers, GALILEO Gold, USA Version</td><td>GMP software version</td><td>GCP software version</td><td>GIP software version</td><td>GPT version</td></tr>
<tr><td>GMP 03.41f US Gold
PN 155596</td><td>GCP 03.40a PN 155599</td><td rowspan="2">GIP 01.10 PN 155582
GIP 01.20 PN 155586[a]</td><td rowspan="2">GPT 01.00 PN 155539</td></tr>
<tr><td>GMP 03.43c US Gold
PN 155709</td><td>GCP 03.41a PN 155712</td></tr>
<tr><td rowspan="3">Part Numbers, GALILEO Gold, USA Version, without infant</td><td>GMP software version</td><td>GCP software version</td><td>GIP software version</td><td>GPT version</td></tr>
<tr><td>GMP 03.41f US Gold
PN 155598</td><td>GCP 03.40a PN 155599</td><td rowspan="2">GIP 01.10 PN 155582
GIP 01.20 PN 155586[a]</td><td rowspan="2">GPT 01.00 PN 155539</td></tr>
<tr><td>GMP 03.43c US Gold
PN 155711</td><td>GCP 03.41a PN 155712</td></tr>
</table>

Table D-3. Software version 3

a. GIP 01.20 does not function with patient monitors that do not support the VueLink Open protocol, for example, Philips monitors using the driver called *VueLink driver for HAMILTON Ventilators*, release AA.

Appendix

E Hardware revisions, features, and compatibility

E.1 Introduction

This appendix brings together information found in other parts of the service manual concerning hardware components that have changed over time. The appendix then adds additional information, such as associated GALILEO serial numbers and the dates of changes.

There are two major sections in this appendix:

- Appendix E.2, *Component history chart*, on page E-2 gives a historical overview of many changed parts. It displays photographs of the latest version of each part.
- Appendix E.3, *Component change details*, on page E-6 gives details about the items in the Appendix E.2, *Component history chart*, and also some additional items. It displays photographs of all major versions of all parts.

Note

- The material in this section is not exhaustive: minor revisions are not shown.
- In the *Component history chart*, on page E-2, the solid arrows represent time periods over which a particular part was kept in production; the dotted arrows represent time periods in which details of some revisions and dates are missing.

E.2 Component history chart

Date	GALILEO Serial Number	Description	***Columns and shelf mount*** **on page E-7** 	***Connector board*** **on page E-8** 	***Control board*** **on page E-9** 
10/1998	1000	Initial status.	PN 155450/00 (standard) PN 155451/00 (short)	PN 155256/00	PN 155154/00
9/1999	1622	Safety valve block PN 155223 Rev 00 deactivated. PN 155338 Rev 00 activated.			
3/2000	1758	Backup batteries introduced together with shelf mount.	PN 155515 shelf mount		
6/2000	1942	GMP assembly PN 155460 Rev 00 introduced.			
9/2001	1971	Inspiratory (servo) valve PN 155161 Rev 02 deactivated. PN 155469 Rev 00 activated.			
4/2002	4001	GMP assembly PN 155499 Rev 00 introduced. Control board PN 155461 Rev 00 introduced.			PN 155461/00
5/2003	4300	Control board PN 155461 Rev 04 introduced.			PN 155461/04
5/2003	4321	GMP assembly PN 396170 Rev 00 introduced.			
10/2003	5150	5 V supply double line implemented.			
10/2004	6234	Introduction of “Transzorberdioden” diodes.		PN 155256/06	
11/2004	6400	“New look” applied, with new front panel keys, silver P&T-knobs, and ID, feature, and battery panel stickers.			
6/2005	6776	“White screen” issue, leading to introduction of GMP PN 396170 Rev 01.			
11/2005 (Current)	7000	**Current status.**		PN 155256/12	
Future	Not yet available	Introduction of mixer block PN 155587 Rev 00 and sensor board PN 155699 Rev 00.			

***Enclosure* on page E-12**	***Feature identification stickers* on page E-14**	***Front panel key sticker* on page E-15**	***GMP* on page E-16**	***Inspiratory (servo) valve* on page E-18**	***Mixer block* on page E-19**
					
PN 155200/00		PN 155260/00	PN 396138/00	PN 155161/00 (PN 155162 with servo bd)	PN 155333/00
			PN 155460/00		
				PN 155491/00 (PN 155496 with servo bd)	
			PN 155499/00		
			PN 396170/00		
PN 155300/03	PN 155589/00-155592/00	PN 155260/01			
			PN 396170/01		PN 155333/01
					PN 155587/00

Date	GALILEO Serial Number	Description	***On/off switch* on page E-20** 	***P&T-knobs* on page E-22** 	***Power supply board* on page E-23** 
10/1998	1000	Initial status.	PN 376007/00	PN 155520/00	PN 396136/00
9/1999	1622	Safety valve block PN 155223 Rev 00 deactivated. PN 155338 Rev 00 activated.			
3/2000	1758	Backup batteries introduced together with shelf mount.	PN 376010/00		PN 155352/00
6/2000	1942	GMP assembly PN 155460 Rev 00 introduced.			
9/2001	1971	Inspiratory (servo) valve PN 155161 Rev 02 deactivated. PN 155469 Rev 00 activated.			
4/2002	4001	GMP assembly PN 155499 Rev 00 introduced. Control board PN 155461 Rev 00 introduced.			
5/2003	4300	Control board PN 155461 Rev 04 introduced.			
5/2003	4321	GMP assembly PN 396170 Rev 00 introduced.			
10/2003	5150	5 V supply double line implemented.			
10/2004	6234	Introduction of "Transzorberdioden" diodes.			
11/2004	6400	"New look" applied, with new front panel keys, silver P&T-knobs, and ID-, feature-, and battery-panel stickers.		PN 155704/00	
6/2005	6776	"White screen" issue, leading to introduction of GMP. PN 396170 Rev 01.			
10/2005 (Current)	7000	**Current status.**			PN 155352/06
Future	Unknown	Introduction of mixer block PN 155587 Rev 00 and sensor board PN 155699 Rev 00.			

***Safety valve block* on page E-24**	***Sensor board* on page E-24**
	
PN 155223/00	PN 155152/00
PN 155338/00	
	PN 155699/00

E.3 Component change details

Backup batteries, 12 V

See also Section 11.9, *Batteries, 12 V*, on page 11-32.

PN 369089

PN 369089, new type

Comment

The original black “BB” backup batteries were replaced by YUASA batteries in March 2004.

Compatibility

There are no compatibility issues between the two types of battery.

Note, however, that backup batteries were not fitted in the earliest GALILEOs. (They are now fitted as standard.)

WARNING

HAMILTON MEDICAL recommends that all GALILEOs are fitted with backup batteries.

Columns and shelf mount

PN 155450 & PN 155451

PN 155515

Comment

The standard (PN 155450) and short (PN 155451) columns were both introduced with the first GALILEOs in October 1998. The shelf mount was introduced in March 2000.

In the first columns, there was no battery backup. Since March 2000, battery backup has been fitted to all columns, complete with new power supply PN 155352, and new on/off switch PN 376010.

Note

The old power supply, PN 396136, is no longer available. To fit a new power supply, order a complete new column or shelf mount.

All shelf mounts have always had battery backup, new power supply PN 155352, and new on/off switch PN 376010.

The original columns were not fitted with a potential equalization terminal. All now are. All shelf mounts have a potential equalization terminal.

Compatibility

There are no compatibility issues, except that the old power supply is no longer available, and the backup batteries can only function with new power supply.

WARNING

Otherwise, all components in the columns and the shelf mount are interchangeable.**HAMILTON MEDICAL recommends that all GALILEOs are fitted with backup batteries.**

Cable 9

PN 155235

Comment

This cable takes power from the power supply in the column to the connector board.

In October 2003, the cable was upgraded with gold contacts and was used in a different manner, in that two wires (not one) were utilized for the 5 V supply. At this time, a new revision connector board, PN 155256/06, was also introduced, complete with gold contacts.

Compatibility

There are no compatibility issues with this cable. However, the later version of the cable, with gold contacts, is naturally better.

Connector board

See also Section 11.10, *Connector board*, on page 11-39.

PN 155256

PN 155256/06

Comment

There are two main revisions of the connector board, each with the same part number.

The second main revision, Revision 06, was introduced in October 2003, has gold contacts for the 5 V power supply from Cable 9, and is equipped with the following cables:

- PN 155548
- PN 155569

Note

The earlier version of the connector board is no longer available.

Compatibility

There are no compatibility issues with the connector board.

Control board

See also Section 11.11, *Control board and GMP assembly*, on page 11-45.

PN 155154

Comment

This control board was fitted in original and Upgrade 1 GALILEOs.

Note

This item is no longer available.

Compatibility

This control board is compatible only with:

- Mounting plate PN 155258.
- GMP PN 396138.
- Original and Upgrade 1 GALILEOs.

PN 155461/00 and later

PN 155461/04 and later

Comment

These revisions of the control board are for Upgrade 2 GALILEOs.

The Revision 04 board, introduced in May 2003, contains microswitches. These are discussed in *Microswitch settings for GMP assemblies* on page 11-51.

Compatibility

This control board is compatible only with:

- Mounting plate PN 155464 (both types).
- GMP PN 155499 (for Revs 00 to 03 of this control board).
- GMP CPU PN 396170 and GMP LCD adapter PN 155563 (for Rev 04 and later of this control board).
- Upgrade 2 GALILEOs.

Control board mounting plate

PN 155258 (shown with fittings)

Comment

This control board mounting plate was for the original and Upgrade 1 GALILEOs.

Note

This item is no longer available.

Compatibility

This mounting plate is compatible only with control board PN 155154. It is not compatible with the two boards shown below.

PN 155464 (shown with fittings)

PN 155464/02, new type with rounded edges

Comment

Mounting plate for control board PN 155461, found in Upgrade 2 GALILEOs.

The Revision 02 has rounded edges enabling additional contact strips to be mounted, thereby ensuring optimal grounding (earthing) connectivity with the enclosure.

Compatibility

There are no compatibility issues between these two mounting plates. You can use either.

However, these mounting plates are compatible only with control board PN 155461.

dc/ac board

See also Section 11.12, *dc/ac board*, on page 11-61.

PN 155415

Comment

dc/ac convertor board. Made by TDK.

Note

This board is no longer available. Order instead, PN 155317 (shown below) together with the list of additional parts detailed in Appendix H.9, *LCD display components*, on page H-7.

Compatibility

This board is no longer available from HAMILTON MEDICAL.

PN 155317

Comment

dc/ac convertor board fitted to Upgrade 2 and some previous versions of GALILEO. Made by Hitachi.

Compatibility

There are no compatibility issues: you can use this board with any GALILEO. However, if you are upgrading from PN 155415 (shown above) you must also order the additional parts detailed in Appendix H.9, *LCD display components*, on page H-7.

Enclosure

PN 155200

PN 155200, updated, rear view

PN 155200, updated, front view

Comment

Design changed in November 2005 approximately, to include new dark frame around LCD display.

This was a part of the "new look" that GALILEO was given, beginning with the new P&T-knobs and front panel key sticker which were renewed in November 2004. (The enclosure was changed some months after the knobs and stickers.)

Compatibility

There are no technical compatibility issues with the front enclosure. However, the enclosure should be used only in combination with the following "new look" GALILEO items:

- Aluminium P&T-knobs PN 155704
- P&T-knob inner PN 155705
- P&T-knob washer PN 254211
- Front panel key sticker PN 155260
- A combination of up to three of the following feature identification stickers:
  - **ASV** (World excluding USA) PN 155589
  - **P/V** (P/V Tool) PN 155591
  - **NEO** (Neonatal) PN 155592
  - **AVtS** (USA only) PN 155590

Fan

See also Section 11.14, *Fan*, on page 11-71.

Part	Comment	Compatibility
PN 155230 	**Comment** Fan alone, without filter, cover, or screen.	**Compatibility** For original or Upgrade 1 GALILEOs only. This fan plugs into the inspiratory (servo) board.
PN 155423/00 	**Comment** Fan alone, without filter, cover, or screen.	**Compatibility** For Upgrade 2 GALILEOs only, this fan has a longer cable than PN 155230, and plugs into the control board.
PN 155423/01 	**Comment** Fan alone, without filter, cover, or screen. Latest, quieter model, with curved blades. Introduced in September 2005.	

Feature identification stickers

See also *GALILEO Installation Guide* PN 608296.

PN 155589 ASV

PN 155591 P/V (P/V Tool)

PN 155592 NEO (Neonatal)

PN 155590 AVtS

Comment

Features stickers were introduced in November 2004 as a part of the GALILEO "new look".

There are a total of four features identification stickers:

- **ASV** (World excluding USA) PN 155589
- **P/V** (P/V Tool) PN 155591
- **NEO** (Neonatal) PN 155592
- **AVts** (USA only) PN155590

Up to three are applied to the front panel to identify additional GALILEO functions, as described in the *GALILEO Installation Guide* PN 608296.

Compatibility

There are no technical compatibility issues with the feature identification stickers (except that they must only be applied to equipment with the features they represent).

However, the stickers should ideally be used only in combination with the following "new look" GALILEO items:

- Aluminium P&T-knobs PN 155704
- P&T-knob inner PN 155705
- P&T-knob washer PN 254211
- Front panel key sticker PN 155260
- "New look" version of the front enclosure, PN 55200.

Front panel key sticker

See also Section 11.16, *Front panel keys*, on page 11-84.

PN 155260

PN 155260 "new look"

Comment

Front panel key sticker. The "new look" sticker was introduced in July 2004.

Compatibility

There are no technical compatibility issues with the front panel keys. However, the "new look" keys should be used only in combination with the following "new look" GALILEO items:

- Aluminium P&T-knobs PN 155704
- P&T-knob inner PN 155705
- P&T-knob washer PN 254211
- "New look" front enclosure PN 155200
- A combination of up to three of the following feature identification stickers:
  - **ASV** (World excluding USA) PN 155589
  - **P/V** (P/V Tool) PN 155591
  - **NEO** (Neonatal) PN 155592
  - **AVtS** (USA only) PN 155590

GMP

See also Section 11.11, *Control board and GMP assembly*, on page 11-45.

PN 396138

Comment

The GMP assembly fitted to original and Upgrade 1 GALILEOs.

There are two slightly different versions: on the original, the program carrier screws to the assembly; on the later type, it clips into place.

3 V battery PN 369069 is mounted on the control board.

Note

This item is no longer available.

Compatibility

This GMP assembly is compatible only with:

- Control board PN 155154.
- Original and Upgrade 1 GALILEOs.

There are no software upgrades or updates available for assemblies with the original, screw-in, data carriers.

PN 155460

Comment

The GMP assembly fitted to later original and Upgrade 1 GALILEOs.

Includes adaptor board PN 155313.

3 V battery PN 369069 is mounted on the GMP assembly.

Compatibility

This GMP assembly is compatible only with GALILEOs with SN 1933 and later, and for Upgrade 1 GALILEOs.

PN 155499

Comment

The GMP assembly fitted to Upgrade 2 GALILEOs.

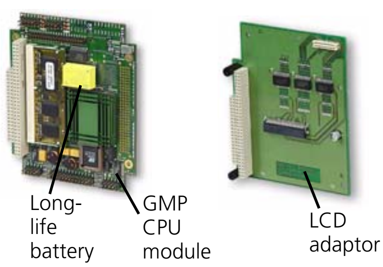
3 V battery PN 369069 is mounted on the control board.

Compatibility

This GMP assembly is compatible only with:

- Control board PN 155461, Revs 00 to 03.
- Upgrade 2 GALILEOs.

PN 396170 & PN 155563



Comment

The GMP assembly fitted to later Upgrade 2 GALILEOs.

It comprises:

- GMP CPU module PN 396170
- GMP LCD adapter PN 155563
- Cable PN 155559 (connects the two boards)

Compatibility

This GMP assembly is compatible only with:

- Control board PN 155461, Revs 04 and later.
- Upgrade 2 GALILEOs.

Gas inlet assembly

See also:

- *Mixer block* on page E-19
- *One-way valves on mixer block* on page E-21
- Section 11.17, *Gas inlet assemblies*, on page 11-89

PN 279677 	**Comment** Gas inlet assembly, for air or oxygen, including: • Base • Bowl PN 279729 • Filter element PN 279676	**Compatibility** Compatible only with old-type mixer block PN 155333.
PN 279729 	**Comment** Bowl.	**Compatibility** Compatible only with old-type mixer block PN 155333.
PN 155713 	**Comment** Bowl and washer.	**Compatibility** Compatible only with new-type mixer block PN 155587 introduced in spring 2006.
PN 279676 	**Comment** Gas inlet microfilter element, 5 μm.	**Compatibility** For gas inlet assembly PN 279677 on old-type mixer block PN 155333.
PN 155714 	**Comment** Gas inlet microfilter element, 5 μm.	**Compatibility** For filter bowl PN 155713 on new type mixer block PN 155587 introduced in spring 2006.

Potential equalization terminal

PN 340272

Comment

The potential equalization terminal is fitted only to later GALILEO columns. However, it is fitted to all GALILEO shelf mounts.

Also shown in the photograph are:

- Colored disk PN 369023
- Non-slip washer PN 411004
- Nut PN 408008

Compatibility

There are no compatibility issues with the potential equalization terminal.

HAMILTON MEDICAL recommends that a potential equalization terminal is fitted to every GALILEO. A small hole must be drilled in order to do this.

Inspiratory (servo) valve

See also Section 11.22, *Inspiratory (servo) valve and servo board*, on page 11-108.

PN 155161

Photographed without servo board and mounting plate

Comment

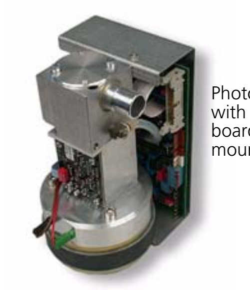
The original version of the inspiratory (servo) valve (PN 155161, or PN 155162 with servo board and mounting plate) was fitted to original and Upgrade 1 GALILEOs.

It is shown photographed without its mounting plate.

Note

This item is no longer available from HAMILTON MEDICAL.

PN 155491



Photographed with servo board and mounting plate

The improved version of the inspiratory valve (PN 155491, or PN 155496 for kit with servo board and mounting plate) was introduced in October 2002, and uses a photo-electronic Position-Sensing Device (PSD) to establish the position of the plunger. Unlike the older mechanical PSD, the new system creates almost no wear within the valve.

Compatibility

There are no compatibility issues between the two versions of the the inspiratory valve.

Loudspeaker support

PN 155357

Comment

The support is fitted to the control board of later GALILEOs, and holds the loudspeaker.

Its purpose is simply to improve the sound of the loudspeaker. It is a recommended, but non-vital part.

Compatibility

There are no compatibility issues with the loudspeaker support. It can be fitted to any of the control boards.

Mixer block

See also:

- *One-way valves on mixer block* on page E-21
- *Gas inlet assembly* on page E-17
- Section 11.25, *Mixer block*, on page 11-135

PN 155333

Comment

Old-type mixer block assembly, including oxygen and air solenoid valves.

Compatibility

Can be mounted only in combination with sensor board PN 155152.

PN 155587

Comment

New-type mixer block assembly, including water traps, and oxygen and air solenoid valves.

This mixer assembly was introduced in spring of 2006.

Compatibility

Can only be mounted in combination with sensor board PN 155699 and longer tube (to tank). Order a length of tube PN 7249082, and cut a part for your use of 99 mm.

Nebulizer compressor and mounting plate
See also Section 11.26, *Nebulizer compressor and solenoid valve*, **on page 11-150**.

Part	Comment	Compatibility
PN 155398  **PN 155398, updated** 	**Comment** The original nebulizer compressor was delivered with a relatively small mounting plate. An updated version was introduced in October 2002, with a larger mounting plate that provides additional protection to other components in GALILEO during transport.	**Compatibility** There are no compatibility issues between the two kinds of nebulizer compressor.

On/off switch

Part	Comment	Compatibility
PN 376007 	**Comment** On/off switch complete.	**Compatibility** Only for original GALILEOs without battery backup. This switch is not compatible with PN 376010 shown below.
PN 376010 	**Comment** On/off switch complete.	**Compatibility** For all GALILEOs with battery backup. Since March 2000, battery backup has been fitted to all columns, complete with new power supply PN 155352. This switch is not compatible with PN 376007 shown above.

One-way valves on mixer block

See also:

- *Gas inlet assembly* on page E-17
- *Mixer block* on page E-19
- Section 11.25, *Mixer block*, on page 11-135

PN 279667

Comment

Used at both air and oxygen inlets in the mixer block.

Compatibility

This valve can only be used in old-type mixer block PN 155333.

PN 155715

Comment

Used at both air and oxygen inlets in the mixer block.

Compatibility

This valve can only be used in new type mixer block PN 155587.

Oxygen cell

See also Section 11.27, *Oxygen cell and cell holder*, **on page 11-161**.

PN 396008

PN 396009

Comment

Both types of oxygen cell are both currently available. For practical purposes, they are identical in performance.

Compatibility

There are no compatibility issues associated with the two kinds of oxygen cell.

P&T-knobs

PN 155201

PN 155704

PN 155705

PN 254211

Comment

The original plastic knob, PN 155520, was fitted to GALILEO until November of 2004, when it was replaced by the "new look" aluminium type, PN 155704.

Both the aluminium and plastic knobs are fitted by mounting them on inner knob PN 155705. The aluminium knob also requires rubber O-ring PN 254211.

Note

Both aluminium and plastic knobs are available.

Compatibility

There are no compatibility issues between the two kinds of knob, plastic or aluminium, as both fit on the same inner knob, PN 155705.

However, the "new look" aluminium knobs should be used only in combination with the following "new look" GALILEO items:

- "New look" front enclosure PN 155200
- Front panel key sticker PN 155260
- A combination of up to three of the following feature identification stickers:
  - **ASV** (World excluding USA) PN 155589
  - **P/V** (P/V Tool) PN 155591
  - **NEO** (Neonatal) PN 155592
  - **AVtS** (USA only) PN 155590

Power supply board

See also Section 11.29, *Power supply and fuses*, on page 11-176.

PN 396136

Comment

Power supply board. Fitted in original GALILEOs with on/off switch PN 37600.

Note

This item is no longer available. You must fit a new column or shelf mount, complete with backup batteries.

Compatibility

Only compatible with GALILEOs that do not have backup batteries. In all cases, these are original GALILEOs without the backup-battery option. All Upgrade 1 and Upgrade 2 GALILEOs have backup batteries fitted as standard, and power supply PN 155352.

WARNING

HAMILTON MEDICAL recommends that all GALILEOs are fitted with backup batteries.

PN 155352

Comment

Power supply board fitted from March 2000, together with backup batteries and on/off switch PN 376010.

Compatibility

Only compatible with GALILEOs that have backup batteries.

Safety valve block

See also Section 11.7, *Ambient valve and patient overpressure valve*, on page 11-19.

PN 155223

PN 155338

Comment

The original safety valve block (PN 155222) was fitted to the original GALILEO. It was superseded by the improved block (PN 155338) in September 1999.

Compatibility

There are no compatibility issues with the safety valve block.

Sensor board

See also: Section 11.31, *Sensor board*, on page 11-192.

PN 155152

Comment

This sensor board was used from the original GALILEO to the spring of 2006, when the new board, PN 155699, was introduced.

Compatibility

Only compatible with old-type mixer block PN 155333.

PN 155699

Comment

Introduced with new type mixer block in spring 2006.

The board is very similar to the original (PN 155152), but some components have different values.

Compatibility

Only compatible with new type mixer block PN 155587.

Appendix

F Historical and background notes

F.1 Introduction

This appendix gives additional information about both GALILEO and this service manual.

F.2 Notes on Section 11.22, *Inspiratory (servo) valve and servo board*

F.2.1 Introduction

The following notes refer to Section 11.22.4, *Description and function*, on page 11-109.

F.2.2 Notes on GALILEO's and RAPHAEL's inspiratory valves

Difference in purpose

The purpose of the inspiratory valve in RAPHAEL is to deliver the air and oxygen mixed in the tank to the breathing circuit, at the ***pressure required*** by RAPHAEL.

The purpose of the inspiratory valve in GALILEO, is to deliver the air and oxygen mixed in the tank to the breathing circuit, at the ***pressures and volumes required*** by GALILEO.

The principle difference between the two valves is therefore the ability of the GALILEO inspiratory valve to measure gas flow through itself (so that the volume of air delivered can be determined).

Differences in design

The determination of all gas flows in HAMILTON MEDICAL AG equipment is made by a calculation based on the measurement of a pressure differential across a known restriction.

To do this, GALILEO's inspiratory valve requires the following additional components:

- A position sensing device (PSD): this indicates the degree of opening of the orifice, and therefore the restriction caused by the orifice to gases passing through it. (The position sensing device is a part of the valve.)
- The *dP servo differential pressure sensor*: this measures the difference in pressure between the two sides of the orifice. (The pressure sensor is mounted on the servo board.)

RAPHAEL's inspiratory valve does not require or have these two components. (However, both valves have a pressure sensor—*Ppat* in GALILEO and Pvent in RAPHAEL—to measure pressure at the inspiratory valve outlet.)

Appendix

G Automated electrical safety tests

G.1 Introduction

HAMILTON MEDICAL AG performs an electrical safety test, according to Norm EN 60601-1, on all the ventilator and compressor units that it manufactures.

It is a legal necessity that you too, after performing a repair or adjustment that includes replacing the power supply or removing any of the internal earth connectors, perform a similar test on your GALILEO. You can do this manually, as described in Section 8, *Checking electrical safety*, on page 8-1. In addition, you can do it automatically, as described here, if you have suitable equipment, such as the Metron Safety Analyzer.

Because details of these automated electrical safety tests depend on the test equipment used, it is impossible to offer here any detailed descriptions. Nevertheless, this section provides a general outline for the parameters that you must test.

Note
The diagrams used in this section refer specifically to the Metron Safety Analyzer QA-90 Mk II. (Figure G-1.)

Figure G-1. The Metron Safety Analyzer

G.2 Considerations

In this section, the following expressions are used:

- "ground", rather than "earth"
- "live" rather than "phase"
- "MD" Measurement Device
- "PE" Protective Earth

G.3 Ground wire resistance

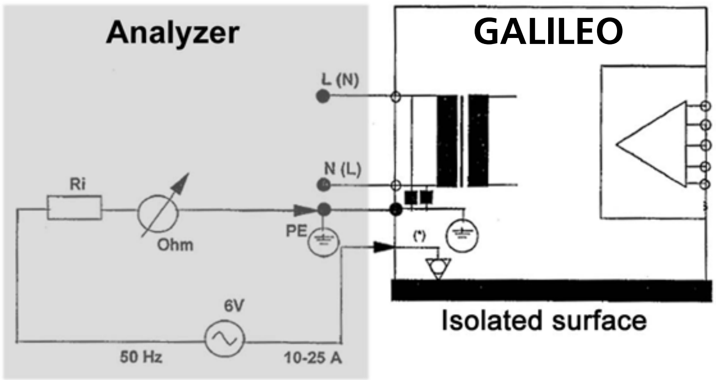


Figure G-2. Ground wire resistance setup

In this test, a measurement is made of the resistance from the potential equalization terminal to the earth, as measured at the end of a power supply cord.

Tolerance: ≤ 200 mΩ

G.4 Insulation resistance

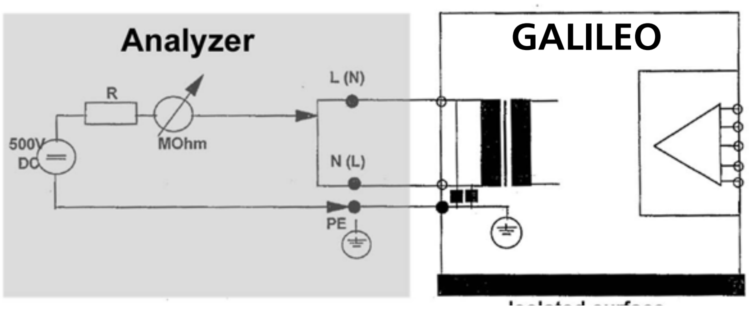


Figure G-3. Insulation resistance setup

In this test, the neutral and live connectors in the unit's power input socket are shorted together, and and the resistance measured between the potential equalization terminal and the shorted pair. Power is not applied to GALILEO during this test.

CAUTION

If the neutral and live connectors are not shorted together, damage can result to the test unit.

Tolerance: ≥ 200 MΩ

G.5 Ground leakage current

In this test, the leakage current is measured from the potential equalization terminal and the electrical ground (which are connected for the test) to an external ground.

G.5.1 Ground leakage current, normal conditions

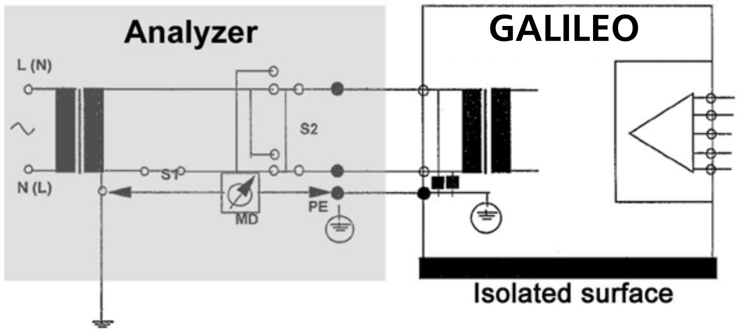


Figure G-4. Ground leakage current (normal conditions) setup

In the normal part of this test, nothing is disconnected.
Tolerance: ≤ 500 μA

G.5.2 Ground leakage current, live open

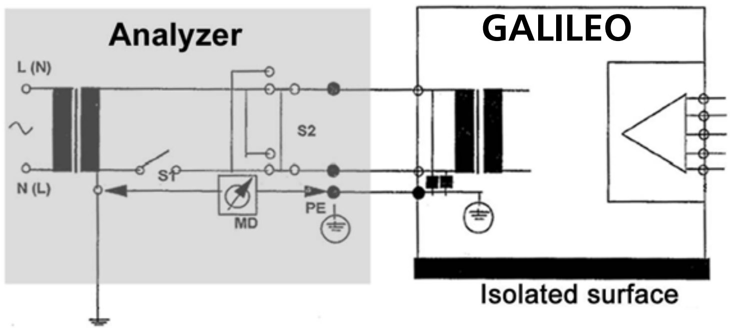


Figure G-5. Ground leakage current (live open) setup

In the live open part of this test, the live connection is disconnected.
Tolerance: ≤ 1000 μA

G.5.3 Ground leakage current, live and neutral reversed, live open

The test is as Section G.5.2, *Ground leakage current, live open*, but with live and neutral reversed.
Tolerance: ≤ 1000 μA

G.5.4 Ground leakage current, live and neutral reversed, neutral open

The test is as Section G.5.2, *Ground leakage current, live open*, but with live and neutral reversed.
Tolerance: ≤ 500 μA

G.6 Chassis leakage current

In this test the leakage current from ground to the unit's chassis is measured.

G.6.1 Chassis leakage current, normal conditions

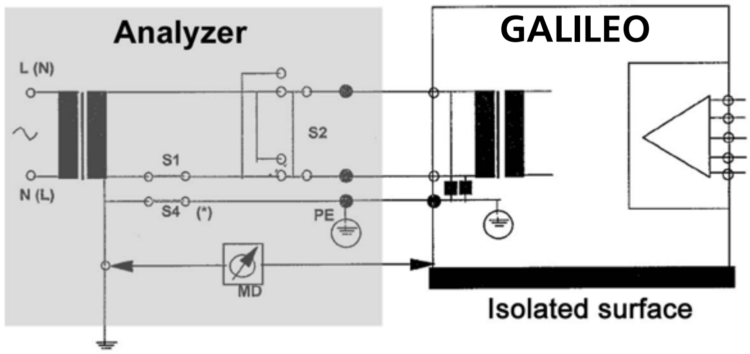


Figure G-6. Chassis leakage current (normal conditions) setup

In the normal part of this test, nothing is disconnected.

Tolerance: ≤ 100 μA

G.6.2 Chassis leakage current, live open

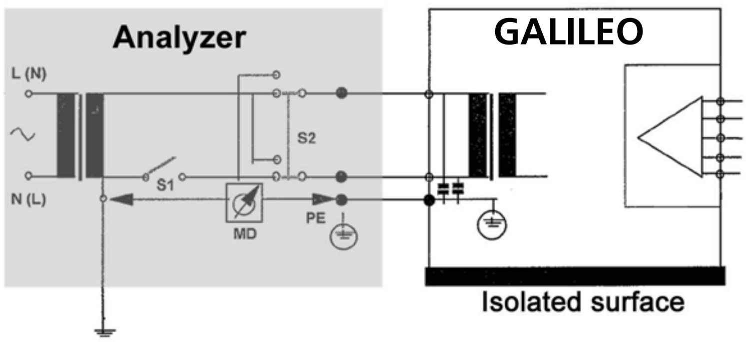


Figure G-7. Chassis leakage current (live open) setup

In the live open part of this test, the live connection is disconnected.

Tolerance: ≤ 500 μA

G.6.3 Chassis leakage current, ground open

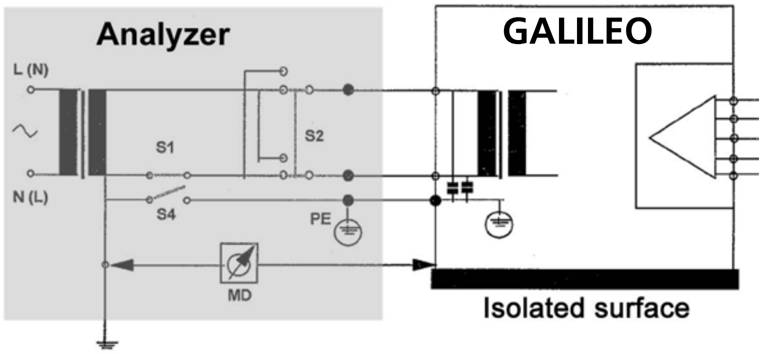


Figure G-8. Chassis leakage current (ground open) setup

In the ground open part of this test, the ground connection is disconnected.

Tolerance: ≤ 500 µA

G.6.4 Chassis leakage test, live and neutral reversed, ground open

Picture as in Section G.6.3, *Chassis leakage current, ground open*.

In this part of this test, the ground connection is disconnected.

Tolerance: ≤ 500 µA

G.6.5 Chassis leakage test, normal conditions, reversed connections

Picture as in Section G.6.1, *Chassis leakage current, normal conditions*.

Tolerance: ≤ 100 µA

G.6.6 Chassis leakage test, open ground, reversed connections

Picture as in Section G.6.3, *Chassis leakage current, ground open*.

Tolerance: ≤ 500 µA

Appendix

H Spare parts

H.1 Introduction to major components

Appendix H lists replacement parts that are individually orderable for GALILEO.

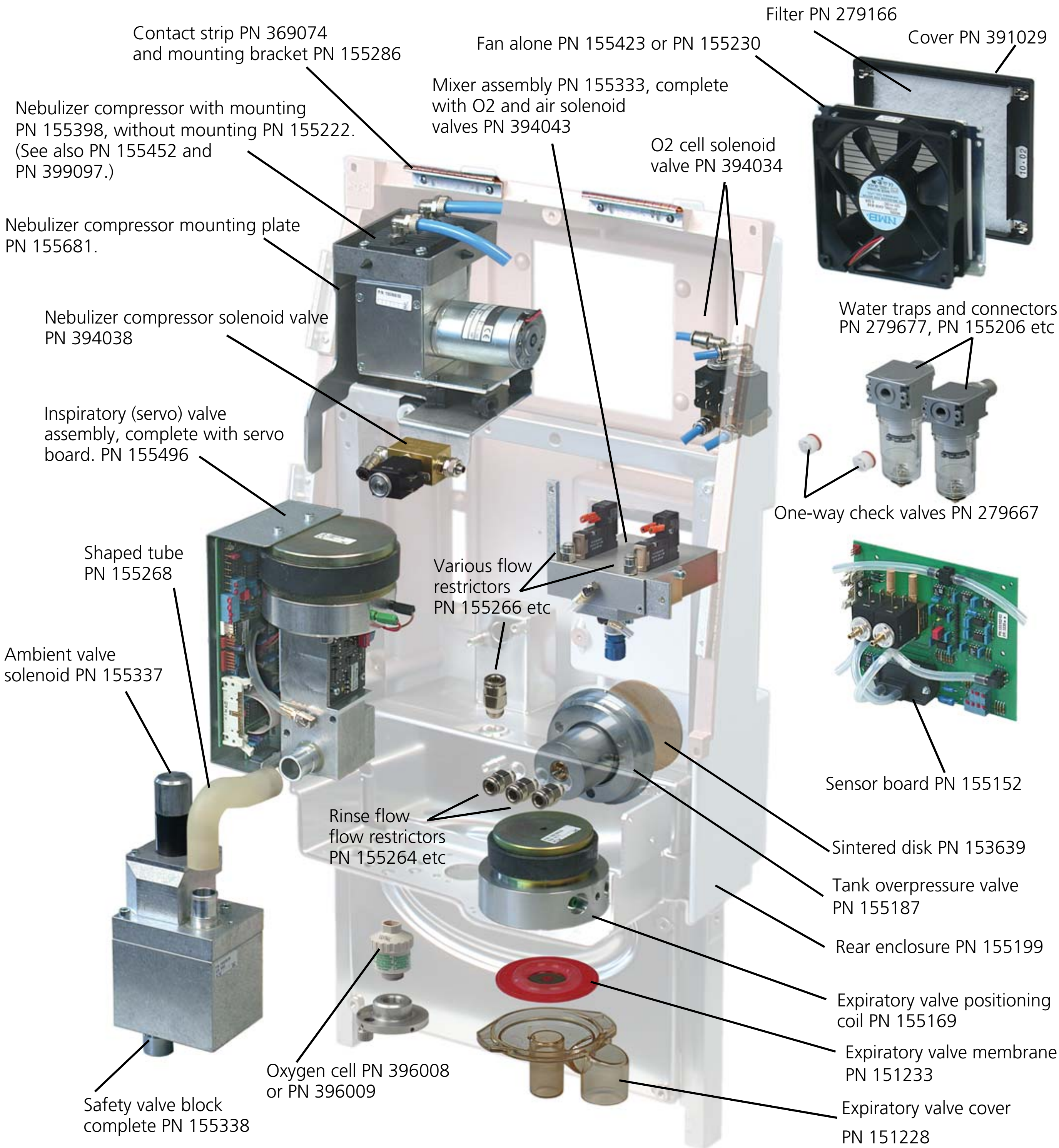
The first sections of the appendix contains three exploded diagrams that enable you to locate major components:

Later sections offer much more comprehensive listings:

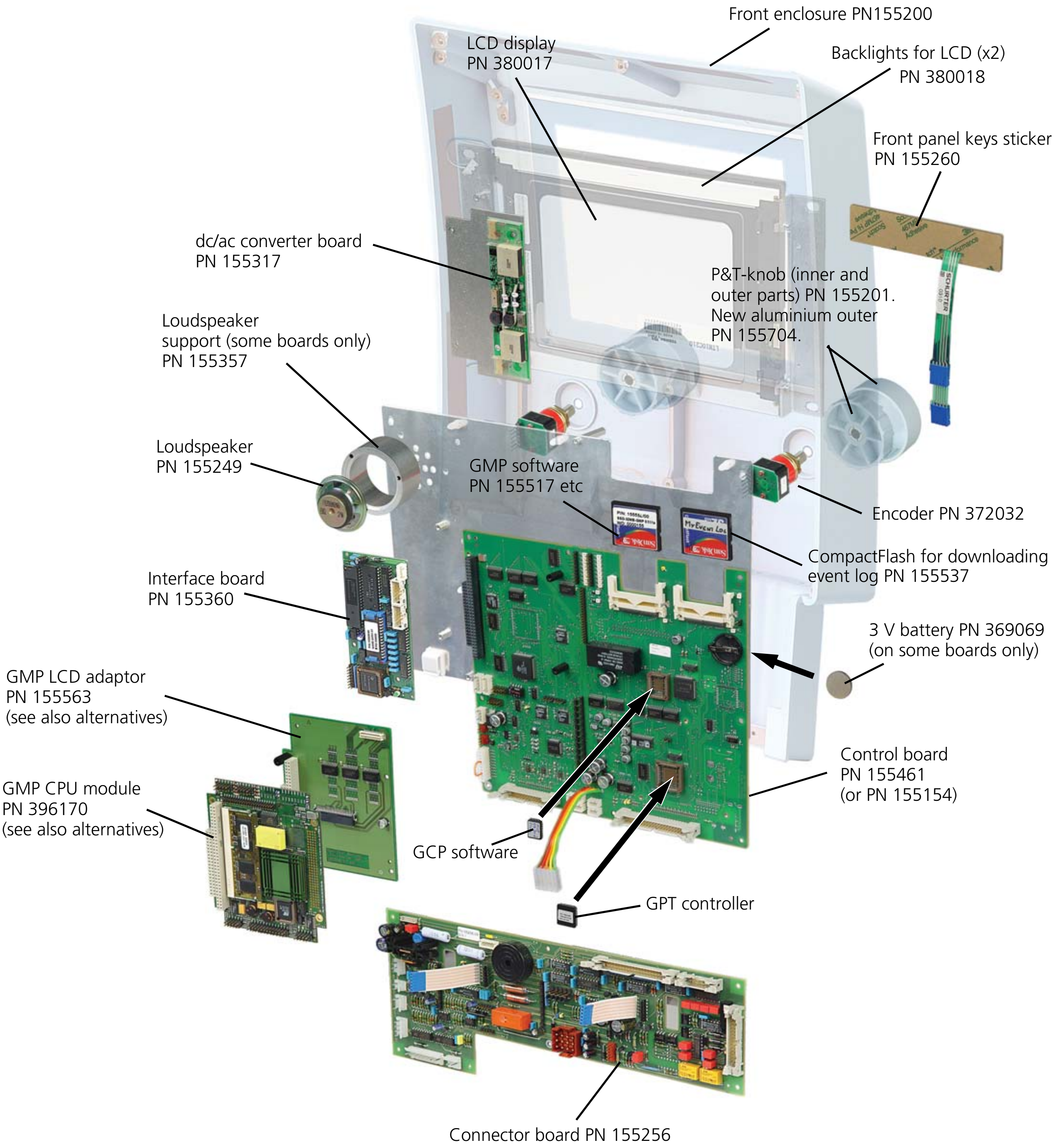
Note

- For information about consumables (such as tubing) and complete assemblies (such as the patient tubing support arm) see the HAMILTON MEDICAL Product Catalog (PN 689060). You can find this on the HAMILTON MEDICAL AG Partner Website (http://www.hamilton-medical.ch/partner-site) under the menu item ***Product Literature***.
- The photographs shown in the later sections are not displayed to scale.

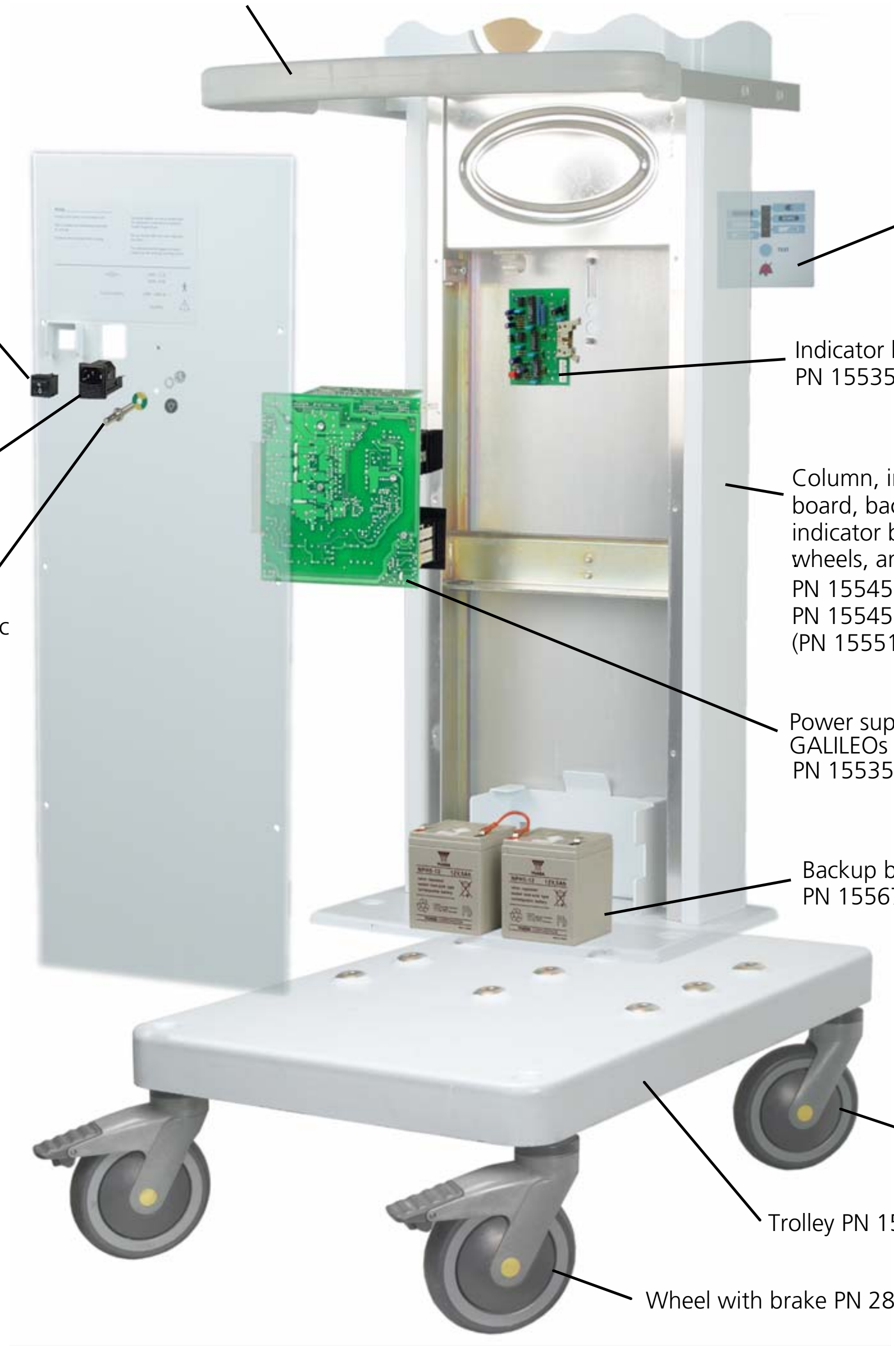
H.2 Major components in rear enclosure



H.3 Major components in front enclosure



H.4 Major components in column



H.5 Upgrade and update kits

For information about the latest upgrade and update kits, go to:

- The HAMILTON MEDICAL AG Partner Web Site (http://www.hamilton-medical.com/partner-site), and click on the menu item called *Updates & Upgrades*.
- The HAMILTON MEDICAL *Product Catalog* (PN 689060). You can also find this on the Partner Web Site, under the menu item called *Product Literature*.

H.6 Additional options kits

155452 Nebulizer option kit. Contains:

- Nebulizer compressor, motor and mounting plate PN 155398 (page H-9)
- Nebulizer solenoid valve PN 394038 (page H-10)

See also:

- PN 155222 on page H-8
- PN 155398 on page H-9
- PN 399097 on page H-27

155530 Communication interface option kit for Upgrade 2 GALILEOs.

H.7 Boards

Note
The servo board is only available in combination with the inspiratory valve. See PN 155496 on page H-8.

155152

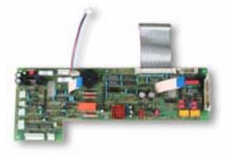
Sensor board for GALILEOs with old type mixer block PN 155333 (page H-8).

See also PN 155699 on page H-6.

155154

Control board for original and Upgrade 1 GALILEO.

155256



Connector board for all models of GALILEO. Supplied complete with following cables:

- PN 155548 on page H-13
- PN 155569 on page H-13

155313

Adaptor board for GMP assembly.

155352

Power supply board for GALILEOs with backup batteries.

See also PN 396136 on page H-7.

155354

Indicator board. (Positioned in column, indicates power supply status.)

155360

Interface board for all upgrade versions.

155460

GMP assembly PC 104 (including adaptor PN 155313) for original GALILEOs with SN 1933 and later, and for Upgrade 1 GALILEOs.

Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch) for more information.

155461

Control board for Upgrade 2 GALILEO.

Note

- Revs 00 to 03 require GMP assembly PN 155499.
- Revs 04 and later can use more recent GMP CPU PN 396170 (page H-7) and GMP LCD adapter PN 155563 (page H-6).

155485

Servo board alone.

Not available. Order instead servo board and inspiratory valve module, PN 155496 on page H-8.

155499

GMP PC 104 assembly for Upgrade 2 GALILEOs with control board PN 155461 (page H-6) Revs 00 to 03. (This assembly comprises the upper two boards of PN 155460.)

Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch) for more information.

155563

GMP LCD adapter. Functions with GMP CPU PN 396170 (page H-7).

For Upgrade 2 GALILEOs with control board PN 155461 (page H-6) Rev 04 and later.

155699

Sensor board for GALILEOs with new type mixer block PN 155587 (page H-9).

See also PN 155152 on page H-5.

396136

Power supply board for GALILEOs without backup batteries.

Not available. Order instead one of the following:

- PN 155450 Standard column. Includes power supply PN 155352 (page H-5).
- PN 155451 Short column. Includes power supply PN 155352 (page H-5).
- PN 155515 Shelf mount. Includes power supply PN 155352 (page H-5).

Note

For more information, see the HAMILTON MEDICAL *Product Catalog* (PN 689060). You can find this on the HAMILTON MEDICAL AG Partner Web Site (http://www.hamilton-medical.com/partner-site) under *Product Literature*.

396138

GMP assembly PC 96 (including adaptor PN 155313) for original GALILEOs before SN 1933. (Shown in photograph with CompactFlash mounted on top.)

Not available. Contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

396170

GMP CPU module PC 104. Functions with LCD adapter PN 155563 (page H-6) and cable PN 155559 (page H-13).

For Upgrade 2 GALILEOs with control board PN 155461 (page H-6) Rev 04 and later.

H.8 Software

Appendix D, *Software revisions, features and compatibility* shows the latest software at the time of writing. To view and print the latest version of this appendix, go to the HAMILTON MEDICAL AG Partner Web Site (http://www.hamilton-medical.com/partner-site) and click on *Updates & Upgrades*. You can also find information about upgrading and updating GALILEO in this part of the web site.

H.9 LCD display components

155317

dc/ac convertor board fitted to Upgrade 2 and some previous versions. Made by Hitachi.

155415

dc/ac convertor board. Made by TDK.

Not available. Order instead:

- PN 155317 (page H-7) dc/ac board
- PN 401036 (page H-20) Screws (x 2)
- PN 155303 (page H-11) Cable
- PN 257012 Small plastic spacers (x2)

380017

LCD display, color 10.4” TFT LCD. (Supplied complete with backlights.)

380018 Old backlight set for LCD display. (Contains two lights.) Appearance very similar to PN 380022 (page H-8).

Note

These lights are not compatible with PN 380022.

380022

New backlight set for LCD display. (Contains two lights.)

Note

These lights are not compatible with PN 380018.

H.10 Valves and assembly groups

155496

Inspiratory (servo) valve PN 155491 assembly, complete with servo board PN 155485. (Replaces PN 155161. (Valve and servo board are available separately.))

155169

Expiratory valve positioning coil (without membrane and cover).

See also:

- PN 151228 on page H-8
- PN 151233 on page H-8
- PN 155187 on page H-8

151228

Cover for expiratory valve PN 155169 (page H-8).

151233

Membrane for expiratory valve PN 155169 (page H-8).

155187

Overpressure valve for tank PN 155176 (page H-14).

155222

Nebulizer compressor and motor (including cable, but with no mounting).

See also:

- PN 155398 on page H-9
- PN 155452 on page H-5
- PN 399097 on page H-27

155333

Mixer block assembly, old type, including oxygen and air solenoid valves.

See also:

- PN 155587 on page H-9
- PN 394043 on page H-10

155337

Ambient valve solenoid.

155338

Safety valve block complete. (Comprises ambient valve and patient overpressure valve.)

See also PN 155337 on page H-9.

155398

Nebulizer compressor and motor, complete with mounting plate PN 155681.

See also:

- PN 155222 on page H-8
- PN 155452 on page H-5
- PN 399097 on page H-27

155587

Mixer assembly, new type, including water traps, and oxygen and air solenoid valves.

See also:

- PN 155333 on page H-8
- PN 155699 on page H-6
- PN 155700 on page H-18
- PN 155701 on page H-19
- PN 155702 on page H-19
- PN 155713 on page H-23
- PN 155714 on page H-23
- PN 155715 on page H-9
- PN 155716 on page H-23
- PN 394043 on page H-10

155715

One-way check valve (x2) for new type mixer block PN 155587 (page H-9). Used at both air and oxygen inlets.

See also PN 279667 on page H-9.

279667

One-way check valve DW10 for old type mixer block PN 155333 (page H-8). Used at both air and oxygen inlets.

See also PN 155715 on page H-9.

394034

Oxygen cell solenoid valve, 12 V dc. (Switches gases for O_2 cell calibration and O_2 monitoring.)

394043

Mixer block solenoid valve, for all types of mixer block, 12 V dc (including 2 screws).

See also:

- PN 155333 on page H-8
- PN 155587 on page H-9

394038

Nebulizer compressor solenoid valve, 12 V dc.

See also PN 155398 on page H-9.

H.11 Cables

155183

Cable 24: control board PN 155461 (page H-6) to O_2 cell.

155184

Cable 18: connector board PN 155256 (page H-5) to autozero valve.

155221

Cable 17: connector board PN 155256 (page H-5) to nebulizer valve PN 394038 (page H-10).

155235

Cable 9: AMP plug. Near power supply board PN 155352 (page H-5), to connector board PN 155256 (page H-5).

155237

Cable 11: connector board to servo board.

Not used on current models. But part available from stock for older models.

155238

Cable 12: interface board to connector board PN 155256 (page H-5) for Upgrade 2.

155239

Cable 13: RS232 and Special interface connector plate PN 155173 (page H-20) to interface board.

Some examples, as in photograph, have ferrite interference suppression.

155242

Cable 19: connector board PN 155256 (page H-5) to mixer valve.

155243

Cable 20: connector board PN 155256 (page H-5) to expiratory valve PN 155169 (page H-8).

155244

Cable 21: connector board PN 155256 (page H-5) to ambient valve.

155246

Cable 23: control board PN 155461 (page H-6) to servo board.

155303 (old type)

Cable 15: dc/ac board from Hitachi PN 155317 (page H-7), to connector board PN 155256 (page H-5) for Upgrade 2.

No longer available.

155303 (new type)

Cable 15: dc/ac board from Hitachi PN 155317 (page H-7), to connector board PN 155256 (page H-5) for Upgrade 2.

Identical in function to old-type cable.

155304

Cable 29: GMP to LCD display.

155364

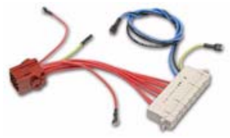
Cable 33: For GALILEOs with control board PN 155154 (page H-5). Connects interface board to connector board PN 155256 (page H-5) Rev 00 to 08.

See also PN 155570 on page H-14.

155367

Cable 35: Power supply board PN 155352 (page H-5) to cable 9 (PN 155235). For short column.

155372

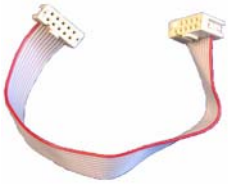


Cable 40: Power supply PN 155352 (page H-5) to AMP plug. For standard length column and for shelf mount.

155424

Cable 46: GMP assembly PN 155499 or GMP assembly PN 396170 to control board PN 155461 (page H-6) for Upgrade 2 GALILEOs.

155425



Cable 47: GMP CPU assembly PN 155499 to interface board.

See also PN 155561.

155426

Cable 48: Control board PN 155461 (page H-6) to interface board for Upgrade 2.

155427

Cable 49: Control board PN 155461 (page H-6) to connector board PN 155256 (page H-5) for Upgrade 2.

155428

Cable 50: Control board PN 155461 (page H-6) to connector board PN 155256 (page H-5) for Upgrade 2.

155446

Cable 43: GMP assembly PN 155460 to GMP adaptor board.

155447

Cable 44: Control board to GMP assembly PN 155460 or GMP assembly PN 155499.

155448

Cable 45: Connector board PN 155256 (page H-5) to dc/ac board PN 155415 (page H-7).

Note

Old dc/ac board PN 155415 from TDK is no longer available. For alternative, see PN 155415 on page H-7.

155504

Cable 51: Control board to servo board for Upgrade 2. 570 mm.

155506

Cable 52: Control board to sensor board for Upgrade 2. 680 mm. (Appearance as PN 155504.).

155508

Cable 53: Connector board PN 155256 (page H-5) to servo board for Upgrade 2 (6-pole connector with 4-pole cable).

155529

Cable 57: Bridge adapter for control board PN 155461 (page H-6) on Upgrade 2 models.

155548

Cable 58: Connector board PN 155256 (page H-5) Rev 07 and later, to control board PN 155461 (page H-6).

155559

Cable 59: GMP CPU PN 396170 on page H-7 to GMP LCD adaptor PN 155563 on page H-6.

For Upgrade 2 models with control board PN 155461 (page H-6) Rev 04 and later.

155560

Cable 60: GMP LCD adaptor PN 155563 on page H-6 to LCD.

For Upgrade 2 models with control board PN 155461 (page H-6) Rev 04 and later.

155561

Cable 61: GMP CPU PN 396170 on page H-7 to interface board.

For Upgrade 2 models with control board PN 155461 (page H-6) Rev 04 and later.

See also PN 155425.

155562

Cable 62: GMP CPU PN 396170 on page H-7 to control board PN 155461 (page H-6) Rev 04 and later.

For Upgrade 2 models.

155569

Cable 63: Connector board PN 155256 (page H-5) Rev 09 to control board PN 155461 (page H-6).

155570

Cable 64: For GALILEOs with control board PN 155154 (page H-5). Connects interface board to connector board PN 155256 Rev 09 and later.

See also:

- PN 155256 on page H-5
- PN 155364 on page H-11

H.12 Cable grips

361003

Cable grip, plastic, (x1).

361007

Cable grip, plastic, in two parts, (x1).

361015

Cable grip, plastic, (x1).

361019

Cable grip, plastic, (x1).

361025

Cable grip, plastic, in two parts, (x1).

361041

Cable grip, plastic (x1).

H.13 Enclosures, chassis, column

155175

Trolley. (Does not include wheels PN 281172 and PN 281173 on page H-24).

155176

Chassis/tank. (Includes no other components.)

155177

Handle.

155199

Enclosure, rear. (Includes no other components.)

155200

Enclosure, front. (Includes no other components.)

155450

Column kit, standard height, containing power supply, backup batteries and indicator board. Also included are the trolley (PN 155175 on page H-14), wheels (PN 281172 and PN 281173 on page H-24), and the handle (PN 155177 on page H-14).

155451 Column kit, short height. Otherwise, identical to PN 155450 above.

155515

Shelf mount, containing power supply, backup batteries, and indicator board.

H.14 O-rings and fuses

254014	O-ring for O_2 cell holder ID 5x2 EPDM.
254029	O-ring between servo valve and tank PN 155176 (page H-14).
254131	O-ring for safety valve block ID 54x3 VITON.
254307	O-ring for old type mixer block PN 155333 (page H-8) ID 40,64 W5,33.
N/A	Fuse 12 V. Not supplied. Replace complete power supply instead. (Section 11.29.8, *Replacing the power supply*, on page 11-179.) See also PN 155352 on page H-5.
363071	Fuse 3ATH (mains primary), for GALILEOs without battery backup. (This is a Time-lag, High breaking capacity fuse.)
363078	Fuse 4ATH (mains primary), for GALILEOs with battery backup. (This is a Time-lag, High breaking capacity fuse.)

H.15 Tubing

151235

PVC tube, clear, 6 mm external, 4 mm internal, 1.5 m.

155268

Shaped tube, servo (inspiratory) valve to safety valve block.

279199

T-piece.

7249057

Silicon tube, clear, 7 mm external, 4 mm internal. State length when ordering.

7249072

PU tube, blue, 6 mm external, 4 mm internal. State length required when ordering.

7249073

PU tube, blue, 8 mm external, 6 mm internal. State length when ordering.

7249082

PU tube, blue, 11.5 mm external, 9 mm internal. State length when ordering.

H.16 Stickers

155260

Front panel keys on sticker.

155339

Battery panel sticker for column. (Covers keys on indicator board.)

155400 Sticker set, German. (Does not include feature stickers.)

The English version of the sticker set is shown in Appendix G.7, *Sticker set English PN 155401*, on page -28.

155401 Sticker set, English. (Does not include feature stickers.)

The English version of the sticker set is shown in Appendix G.7, *Sticker set English PN 155401*, on page -28.

155402 Sticker set, French. (Does not include feature stickers.)

The English version of the sticker set is shown in Appendix G.7, *Sticker set English PN 155401*, on page -28.

155403 Sticker set, Spanish. (Does not include feature stickers.)

The English version of the sticker set is shown in Appendix G.7, *Sticker set English PN 155401*, on page -28.

155404 Sticker set, Italian. (Does not include feature stickers.)

The English version of the sticker set is shown in Appendix G.7, *Sticker set English PN 155401*, on page -28.

155421

GALILEO Gold sticker.

155420

GALILEO Upgrade 1 sticker. (Appearance similar to PN 155421.)

155422

Classic GALILEO sticker. (Appearance similar to PN 155421.)

155589

ASV identity sticker.

155590

AVtS identity sticker.

155591

P/V Tool identity sticker.

155592

Neonatal identity sticker.

H.17 Adaptors and connectors

155190

Air connector, DISS, ventilator side, for old type mixer block PN 155333 (page H-8).

See also:

- PN 155701 on page H-19
- PN 279592 on page H-19

155205

Oxygen connector, DISS, ventilator side, for old type mixer block PN 155333 (page H-8).

See also:

- PN 155701 on page H-19
- PN 279622 on page H-19

155206

Air connector, NIST, ventilator side, for old type mixer block PN 155333 (page H-8). Replaces DISS connector.

See also:

- PN 155700 on page H-18
- PN 500295 on page H-19

155207

Oxygen connector, NIST, ventilator side, for old type mixer block PN 155333 (page H-8). Replaces DISS connector.

See also:

- PN 155700 on page H-18
- PN 500296 on page H-19

155212

Tubing connector for Flow Sensor. (This is screwed into the GALILEO front panel.)

155213

Tubing connector for nebulizer. (This screwed into the GALILEO front panel.)

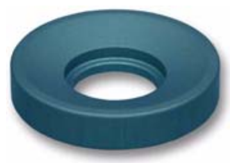
155216

Color-coded ring for Flow Sensor connector, dark blue.

155217

Color-coded ring for Flow Sensor connector, silver.

155218



Color-coded ring for auxiliary pressure connector, light blue.

155219

Color-coded ring for nebulizer connector, gold.

155330 Air and oxygen connector kit (NIST) for old type mixer block PN 155333 (page H-8).

Contains:

- PN 155206 on page H-18 (air connector at ventilator)
- PN 155207 on page H-18 (oxygen connector at ventilator)
- PN 500295 on page H-19 (air connector on hose)
- PN 500296 on page H-19 (oxygen connector on hose)

See also:

- PN 155333 on page H-8
- PN 155702 on page H-19

155700 Oxygen and air connectors, NIST, ventilator side, for new type mixer block PN 155587 on page H-9. (Can be used to replace DISS connectors.)

Appearance very similar to PN 155701 on page H-19.

See also:

- PN 155206 on page H-18
- PN 155207 on page H-18

155701

Oxygen and air connectors, DISS, ventilator side, for new type mixer block PN 155587 on page H-9.)

See also:

- PN 155205 on page H-17
- PN 155190 on page H-17

155702 Air and oxygen connector kit (NIST) for new type mixer PN 155587. Can be used to replace DIST connectors.

Contains:

- PN 155700 (page H-18) air and oxygen connectors at ventilator
- PN 500295 (page H-19) air connector on hose
- PN 500296 (page H-19) oxygen connector on hose
- PN 239006 pin wrench (spanner)
- PN 279731 hose clamp
- PN 608057 installation guide

See also:

- PN 155587 on page H-9
- PN 155330 on page H-18

279592

Air connector in two parts, DISS. (Hose side.)

279622

Oxygen connector in two parts, DISS. (Hose side.)

279671

Tube connector, right-angled.

(Connects nebulizer compressor PN 155398 (page H-9) to inside of front panel.)

279674

Tube connector, straight. 8 mm.

421011

Nut for tube connector.

500295

Air connector in two parts, NIST. (Hose side.)

See also:

- PN 279592 on page H-19
- PN 155206 on page H-18

500296

Oxygen connector in two parts, NIST. (Hose side.)

See also:

- PN 279622 on page H-19
- PN 155207 on page H-18

H.18 Mounting plates, screws and spacers

155173

Communication interface connector plate.

155464

Mounting plate for control board PN 155461 (page H-6) for Upgrade 2.

400001

Screw, M3, 5 mm, metal.

400029

Screw, M4, 18 mm, metal. (For enclosure.)

420573

Screw, M3, 5 mm, grey plastic.

420585

Screw, M3, 25 mm, white plastic.

369072

Screw, nut and washer set, metal (x2). (For communication interface connector plate PN 155173 on page H-20.)

257012

Plastic spacers (x2).

257031

Spacing bolt, hexagonal, M3, 35 mm, metal, with two female threads.

257048

Spacer, hexagonal, M3, 6 mm, metal.

257053

Spacer, cylindrical, black plastic.

257057

Spacer, hexagonal, M3, 15 mm, black plastic, with two female threads.

257058

Spacer, hexagonal, M3, 15 mm, black plastic with one male and one female thread.

362051

Spacer, white plastic. For mounting control board PN 155461 (page H-6) on mounting plate.

H.19 Miscellaneous

153217

Sintered disk for old type mixer block PN 155333 (page H-8).

See also PN 155717 on page H-23.

153639

Sintered disk sound absorber for tank overpressure valve PN 155187 (page H-8).

155537

Specially formatted CompactFlash data carrier for downloading the event log. (This product does not contain data when delivered.)

155201

Plastic P&T-knob, including inner (x1) and outer (x1) parts. For GALILEOs built before November 2004.

See also:

- PN 155704 on page H-23
- PN 155705 on page H-23

155230

Fan alone, without filter, cover, or screen, for Upgrade 1 and original models. (Plugs into the *servo board*.)

See also:

- PN 155423 on page H-22
- PN 279166 on page H-24
- PN 396166 on page H-26
- PN 391029 on page H-27
- PN 391030 on page H-27

155423

Fan alone, without filter, cover, or screen, for Upgrade 2 models. (Plugs into the *control board*.)

As above. Latest, quieter model. Introduced approximately September 2005. (Part number and all fittings remain the same.)

See also:

- PN 279166 on page H-24
- PN 391029 on page H-27
- PN 391030 on page H-27

155249

Loudspeaker for Upgrade 2, complete, including cable. (Also suitable for original and Upgrade 1 GALILEOs.)

155264

Flow restrictor 100, marked with white paint. Controls rinse flow from tank PN 155176 (page H-14) for Paux.

155265

Flow restrictor 250, unmarked with paint (x2). For use with old type mixer block PN 155333 (page H-8).

(One pair control rinse flows from tank PN 155176 (page H-14) to Flow Sensor. One pair control air and oxygen flow from mixer block to O_2 cell.)

See also PN 155716 (page H-23).

155266

Flow restrictor 2500, marked with red paint. (Controls sample flow from tank PN 155176 (page H-14) to O_2 cell.)

155286

Mounting bracket for contact strip PN 369074 on page H-25.

155357

Support for loudspeaker PN 155249 (page H-22).

155676

Backup battery replacement kit, 12 V.

Contains:

- PN 369089 backup batteries, 12 V (x2)
- PN 155519 cable 54 (Not shown here.)
- PN 155527 cable 55 (Not shown here.)
- PN 155528 cable 56 (Not shown here.)

155704

Outer aluminium P&T-knob (x1) for new look GALILEOs built after November 2004.

Does not include:

- Inner knob PN 155705 on page H-23.
- O-ring PN 254211 on page H-24.

See also PN 155201 on page H-21.

155705

Inner P&T-knob (x1) for new look GALILEOs built after November 2004.

See also:

- PN 155704 on page H-23
- PN 254211 on page H-24

155713

Filter bowl (x2) with washer (x2) for new type mixer block PN 155587 (page H-9).

See also PN 279677 on page H-24.

155714

Gas inlet microfilter element (x2), 5 µm, for filter bowl PN 155713 on new type mixer block PN 155587 (page H-9).

See also PN 279676 on page H-24.

155716

Flow restrictor 250, unmarked with paint (x2). For use with new type mixer block PN 155587 (page H-9).

(One pair control rinse flows from tank PN 155176 (page H-14) to Flow Sensor. One pair control air and oxygen flow from mixer block to O2 cell.)

See also PN 155265 on page H-22.

155717

Sintered disk for new type mixer block PN 155587 (page H-9).

See also PN 153217 on page H-21.

157272

Oxygen cell holder.

See also:

- PN 396008 on page H-26
- PN 396009 on page H-26

254211

O-ring for aluminium P&T-knob for new look GALILEOs built after November 2004.

See also:

- PN 155704 on page H-23
- PN 155705 on page H-23

279166

Fan filter element, 120x120x3.

See also:

- PN 155230 on page H-21
- PN 155423 on page H-22
- PN 391029 on page H-27
- PN 391030 on page H-27

279676

Gas inlet microfilter element, 5 μm, for gas inlet assembly PN 279677 on old type mixer block PN 155333 (page H-8).

See also:

- PN 155714 on page H-23
- PN 279677 on page H-24

279677

Gas inlet assembly, for air or oxygen, including: base, filter bowl, filter element, for old type mixer block PN 155333 (page H-8).

(NIST or DISS adaptor not included: see Appendix H.17, *Adaptors and connectors*.)

See also:

- PN 155713 on page H-23
- PN 279729 on page H-24

279729

Filter bowl for water trap, for new type mixer block PN 155587 (page H-9).

See also:

- PN 279677 on page H-24
- PN 155713 on page H-23

279808

Mounting assembly for microfilter element PN 279676, for gas inlet assembly PN 279677 on old type mixer block PN 155333 (page H-8).

281172

Wheel for trolley, 125 mm, with brake and ESD protection.

281173

Wheel for trolley, 125 mm, without brake, with ESD protection.

340272

Potential equalization terminal DIN 42801 M6, 15mm. Also shown are:

- Colored disk PN 369023
- Non-slip washer PN 411004
- Nut PN 408008

340345

Mains socket, supplied without fuses.

(See Appendix H.14, *O-rings and fuses*, on page H-15 for fuses.)

341326

Dust cap, 9 pin. (For interface connector plate PN 155173 on page H-20.)

341327

Dust cap, 15 pin. (For interface connector plate PN 155173 on page H-20.)

361021

Mains power cable grip. (Screwed into the back of the column on GALILEO.)

362049

Support for power supply without battery.

362058

Support for power supply PN 155352 (page H-5) with battery.

369069

Battery 3 V. (Type CR 2032).

Used on all control boards ***with exception of*** control board PN 155461 (page H-6) Rev 4, when this board fitted with:

- GMP CPU PPN 396170 on page H-7 together with
- GMP LCD adaptor PN 155563 on page H-6

(The GMP CPU module has its own battery.)

369074

Contact strip, small. Used around upper part of rear enclosure PN 155199 (page H-15).

See also:

- PN 369082 on page H-25
- PN 155286 on page H-22

369082 Contact strip, large. Used in lower part of rear enclosure PN 155199 on page H-15. Appearance similar to PN 369074 (page H-25).

See also:

- PN 155286 on page H-22
- PN 369074 on page H-25

369089

Backup battery set, 12 V. (Set contains two batteries.)

372032

Encoder (16 positions). Connects to P&T-knobs.

See also:

- PN 155704 on page H-23
- PN 155705 on page H-23
- PN 155201 on page H-21
- PN 254211 on page H-24

376007

On/off switch complete. For GALILEOs without battery backup.

376010

On/off switch complete. For GALILEOs with battery backup.

396008

Oxygen cell from MSA.

See also PN 396009 on page H-26.

396009

Oxygen cell from Teledyne.

See also PN 396008 on page H-26.

396129

Adaptor, serial, 9 pin male to 25 pin female. (Supplied loose.)

396154

Adaptor, serial, 9 pin male to 25 pin male. (Supplied loose.)

396165

Filter/adaptor, 9 pin. (For interface connector plate PN 155173 on page H-20.)

396166

Filter/adaptor, 15 pin. (For interface connector plate PN 155173 on page H-20.)

391029

Fan cover.

See also:

- PN 155230 on page H-21
- PN 155423 on page H-22
- PN 279166 on page H-24
- PN 391030 on page H-27

391030

Fan screen (screwed to fan).

See also:

- PN 155230 on page H-21
- PN 155423 on page H-22
- PN 279166 on page H-24
- PN 391029 on page H-27

399097

Nebulizer maintenance kit (includes 1 x membrane, 2 x flaps, 2x O-rings).

See also:

- PN 155222 on page H-8
- PN 155398 on page H-9
- PN 155452 on page H-5

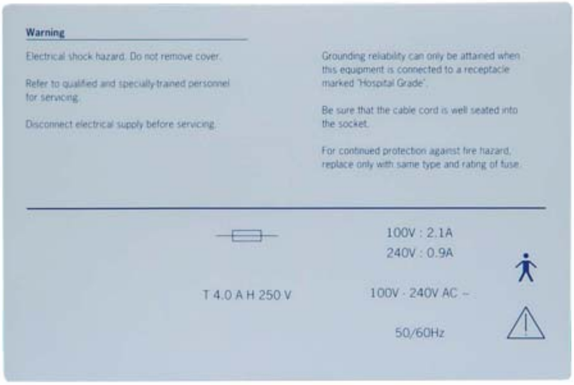
H.20 Service documentation in English

For more information about documentation, especially in non-English languages, see:

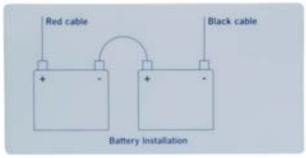
- The HAMILTON MEDICAL AG Partner Website (http://www.hamilton-medical.ch/partner-site).
- The HAMILTON MEDICAL *Product Catalog* (PN 689060), also available on the Partner Website.

G.7 Sticker set English PN 155401

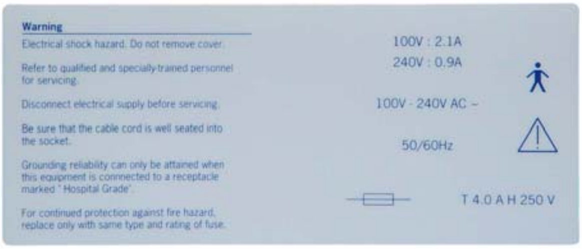
Note
The stickers shown on this page are a subset of those shown in Appendix H.16, on page H-16.



Sticker 2 (rear panel, standard column or shelf-mount)

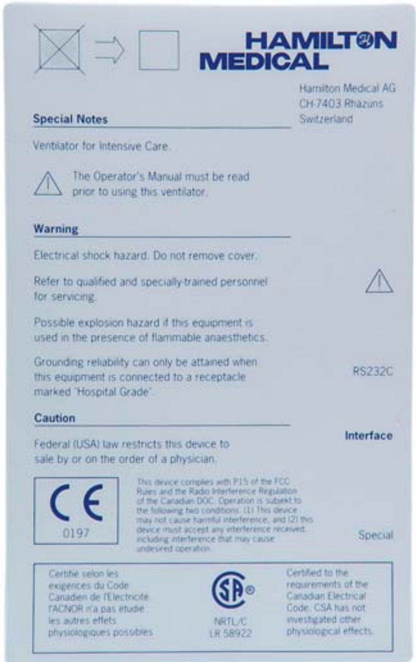


Sticker 1 (inside standard and short columns)



Sticker 3 (rear panel, short column)

Sticker 5 (rear panel, all cases)



Sticker 4 (rear panel, all cases)

Sticker 6 (front panel, all cases)

This sticker not required

Sticker 7 (front panel, all cases)

Sticker 10 (front panel, all cases)

Sticker 8 (front panel without nebulizer option)

Sticker 9 (front panel with nebulizer option)

Table G-1. Sticker set PN 155401 (not shown to scale)

Appendix

I Schematics

I.1 Introduction

The expression “schematic” is used to apply to a range of drawings and diagrams. The tables in this section list most of the schematics that apply to:

- Original GALILEOs
- Upgrade 1 GALILEOs
- Upgrade 2 GALILEOs

A selection of these schematics is also included in this section, as indicated by the *Included in manual* column in each table. Normally it is only the most recent schematic of each type that is present. If you require older schematics, you can order them from HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

Note

- One board revision can have two or more schematics revisions associated with it. This is because schematics can be revised independently of a board revision. This happens when a schematic is found to have a mistake.
- One component placement diagram can have one or more boards associated with it. This is because a change to a board specification does not always affect the layout of components.

This appendix is divided into the following sections:

- Appendix I.2, *GALILEO overviews*
- Appendix I.3, *Connector board PN 155256*
- Appendix I.4, *Control boards PN 155154 and PN 155461*
- Appendix I.5, *Indicator board PN 155354*
- Appendix I.6, *Interface board PN 155360*
- Appendix I.7, *Power supply PN 155352*
- Appendix I.8, *Sensor boards PN 155152 and PN 155699*
- Appendix I.9, *Servo boards PN 155150 and PN 155485*
- Appendix I.10, *GMP assemblies PN 155460, PN 155499 and PN 396170*

I.2 GALILEO overviews

The following diagrams offer overviews of the wiring and pneumatics networks linking the various parts of the GALILEO.

I.2.1 GALILEO original and Upgrade 1 overviews

Schematic title and number	Description	Schematic revision	Included in manual
GALILEO Wiring Diagram ZCH604918	Diagram showing connection between all GALILEO circuit boards. Applies to versions without the battery backup in the column.	00	No
		01	Yes
GALILEO Wiring Diagram (with Battery Backup) ZCH604947	Diagram showing connection between all GALILEO circuit boards. Applies to versions with the battery backup in the column.	00	Yes
GALILEO Block Diagram ZCH614024	Diagram showing high-level pneumatics and electronics interconnections for GALILEOs without battery backup.	00	No
		01	Yes
GALILEO Block Diagram (with Battery Backup) ZCH614201	Diagram showing high-level pneumatics and electronics interconnections for GALILEOs with battery backup.	00	Yes

I.2.2 GALILEO Upgrade 2 overviews

Schematic title and number	Description	Schematic revision	Included in manual
GALILEO Upgrade 2 Block Diagram ZCH614201	Diagram showing high-level pneumatics and electronics interconnections. (All models have battery backup.)	01	No
		02	Yes
GALILEO Upgrade 2 Wiring Diagram ZCH604947	Diagram showing connection between all GALILEO circuit boards. (All models have battery backup.)	01	No
		02	No
		03	Yes

I.3 Connector board PN 155256

Schematic title and number	Description	Board revision	Schematic revision	Included in manual
Connector Board mit Interface BSP155256 **Note** Despite the title, the connector board does not include an interface.	Component placement diagram of the *connector board*.	00	00	No
		01	01	No
		02	02	No
			03	No
		03	04	No
		04	05	No
			06	No
		05	07	No
		06	08	No
			09	No
		07	10	No
		08	11	No
		09	?	No
		10	?	No
		11	?	No
		12	13	Yes
Connector Board mit Interface SA604913 **Note** Despite the title, the connector board does not include an interface.	Circuit diagram of the *connector board*.	00	00	No
		01	01	No
		02	02	No
		03	03	No
		04	04	No
		05	05	No
		06	06	No
		07	07	No
		08	08	No
		09	09	No
			10	No
			11	No
			12	Yes

I.4 Control boards PN 155154 and PN 155461

I.4.1 Control board PN 155154 for original and Upgrade 1 GALILEOs

Schematic title and number	Description	Board revision	Schematic revision	Included in manual
Control Board BSP155154	Component placement diagram of the *control board*.	00	00	No
		01	01	No
		02	02	No
		03	03	No
		04		No
		05		No
		06	04	No
		07	05	No
		08	06	No
		09	07	No
		10	08	Yes
Control Board SA604911	Circuit diagram of the *control board*.	00	00	No
		01		No
		02	01	No
		03	02	No
		04	03	No
		05	04	No
		06	05	No
		07	06	No
		08	07	No
		09	08	No
		10	09	Yes

I.4.2 Control board PN 155461 for Upgrade 2 GALILEOs

Schematic title and number	Description	Board revision	Schematic revision	Included in manual
Control board 2 Standardbestueckung BSP155462 (Blatt 1)	Component placement diagram of the *control board*.	00	00	No
		01	01	No
		02	02	No
		04	04	No
Control Board 2 Standardbestueckung ungeprueft BSP155462 (Blatt 1)		05	05	Yes
Control board 2 Standardbestueckung BSP155462 (Blatt 2)	Component placement diagram of the *control board*, showing location of components, but not showing components.	00	00	No
		01	01	No
		02	02	No
		03	03	No
		04	04	No
		05	05	No
Control Board 2 Prozessor SA604986 (Blatt 1)	Circuit diagram of the control board processor.	00	00	No
		01	01	No
		02	02	No
		03	03	No
		04	04	No
		05	05	Yes
Control Board 2 Diverse Schnittstellen SA604986 (Blatt 2)	Circuit diagram showing various interfaces on the control board. (For instance, CompactFlash contacts, test pins, connectors to other boards.)	00	00	No
		01	01	No
		02	02	No
		03	03	No
		04	04	No
Control Board 2 Connectors SA604986 (Blatt 2)		05	05	Yes

I.5 Indicator board PN 155354

<table>
<tr><th>Schematic title and number</th><th>Description</th><th>Board revision</th><th>Schematic revision</th><th>Included in manual</th></tr>
<tr><td rowspan="5">Ueberwachungs-Board
BSP155354</td><td rowspan="5">Component placement diagram of the indicator board.</td><td>00</td><td>01</td><td>No</td></tr>
<tr><td>01</td><td rowspan="4">02</td><td rowspan="4">Yes</td></tr>
<tr><td>02</td></tr>
<tr><td>03</td></tr>
<tr><td>04</td></tr>
<tr><td rowspan="5">Ueberwachungs-Board
SA604944</td><td rowspan="5">Circuit diagram of the indicator board.</td><td>00</td><td>01</td><td>No</td></tr>
<tr><td>01</td><td rowspan="2">02</td><td rowspan="2">No</td></tr>
<tr><td>02</td></tr>
<tr><td>03</td><td>03?</td><td>No</td></tr>
<tr><td>04</td><td>04</td><td>Yes</td></tr>
</table>

I.6 Interface board PN 155360

<table>
<tr><th>Schematic title and number</th><th>Description</th><th>Board revision</th><th>Schematic revision</th><th>Included in manual</th></tr>
<tr><td rowspan="6">Interface Board
BSP155360</td><td rowspan="6">Component placement diagram of the interface board.</td><td>00</td><td rowspan="6">00</td><td rowspan="2">Yes</td></tr>
<tr><td>01</td></tr>
<tr><td>02</td><td></td></tr>
<tr><td>03</td><td></td></tr>
<tr><td>04</td><td></td></tr>
<tr><td>05</td><td></td></tr>
<tr><td rowspan="6">Interface Board
SA604934</td><td rowspan="6">Circuit diagram of the interface board.</td><td>00</td><td>00</td><td>No</td></tr>
<tr><td>01</td><td>01</td><td>No</td></tr>
<tr><td>02</td><td>?</td><td>No</td></tr>
<tr><td>03</td><td>?</td><td>No</td></tr>
<tr><td>04</td><td>?</td><td>No</td></tr>
<tr><td>05</td><td>03</td><td>Yes</td></tr>
</table>

I.7 Power supply PN 155352

Note

- Power supply schematics follow different naming and numbering conventions to the other schematics shown in this appendix.
- Unlike other schematics, you cannot order back-dated diagrams of the power supply.

Schematic name and number	Description	Board revision	Included in manual
USV140_A07_MB.sch (There are two diagrams of this name and number.)	Circuit diagram of the main board on the power supply.	Rev. 05 (Note: The board is marked A 10.)	Yes
USV140_A03_CB.sch	Circuit diagram of the small additional board mounted on the main power supply board. This is sometimes called the Ueberwachungs Board.	As main board	Yes
USV140_A04_MB	Component placement diagram of the main board on the power supply	Rev. 05 (Note: The board is marked A 10.)	Yes
USV140_A03_CB	Component placement diagram of the small additional board mounted on the main power supply board. This is sometimes called the Ueberwachungs Bord.	As main board	Yes

I.8 Sensor boards PN 155152 and PN 155699

I.8.1 Sensor board PN 155152

Schematic title and number	Description	Board revision	Schematic revision	Included in manual
Sensor Board BSP155152	Component placement diagram of the *sensor board*.	00	00	No
		01	01	No
		02	02	No
			03	No
		03	04	Yes
Sensor board SA604912	Circuit diagram of the *sensor board*.	00	00	No
		01	01	No
		02	02	No
			03	No
		03	04	No
Sensor Board SA604912			05	Yes

I.8.2 Sensor board PN 155699

Schematic title and number	Description	Board revision	Schematic revision	Included in manual
Sensor Board 2 BSP 155699	Component placement diagram of the *sensor board*.	00	00	Yes
Sensor board Sensor board 2 SA604912	Circuit diagram of the *sensor board*.	00	06	Yes

I.9 Servo boards PN 155150 and PN 155485

I.9.1 Servo board PN 155150

This board is a part of servo (inspiration) valve assembly PN 155161. This item is now out of date. To order a replacement, order PN 155496 servo board and inspiratory valve module complete.

Schematic title and number	Description	Board revision	Schematic revision	Included in manual
Servo Board BSP155150	Component placement diagram of the *servo board*.	00	00	No
		01	01	No
		02	02	No
		03	03	No
		04	04	No
		05	05	Yes
Servo Board SA604910	Circuit diagram of the *servo board*.	00	00	No
		01	01	No
			02	No
		02	03	No
		03	04	No
			05	No
		04	06	No
		05	07	Yes

I.9.2 Servo board PN 155485

This board is a part of servo (inspiration) valve assembly PN 155496. You cannot order the board separately.

Schematic title and number	Description	Board revision	Schematic revision	Included in manual
Servo Board BSP155485	Component placement diagram of the *servo board*.	00	00	No
		01	02	No
		02	02	No
		03	03?	Yes
		04		
		05		
Servo board SA604995	Circuit diagram of the *servo board*.	00	00	No
		01	01	No
		02	02	No
		03	03?	No
		04	04?	No
		05	05?	Yes

I.10 GMP assemblies PN 155460, PN 155499 and PN 396170

The *GMP* is an assembly of several small boards. In some documentation, it is referred to as the single board computer.

The main parts of the assembly are:

- The GMP. This is a micoprocessor that controls the user interface.
- The VGA (video adaptor).
- The GMP program (held on a CompactFlash).

In original and Upgrade 1 GALILEOs there are three boards. In Upgrade 2 GALILEOs there are two boards, as the CompactFlash is mounted on the control board.

I.10.1 GMP assembly PN 155460 for original and Upgrade 1 GALILEOs

Schematic title and number	Description	Board revision	Schematic revision	Included in manual
Single Bord Computer ZCH155460	Exploded diagram of the single board computer.	00	00	Yes

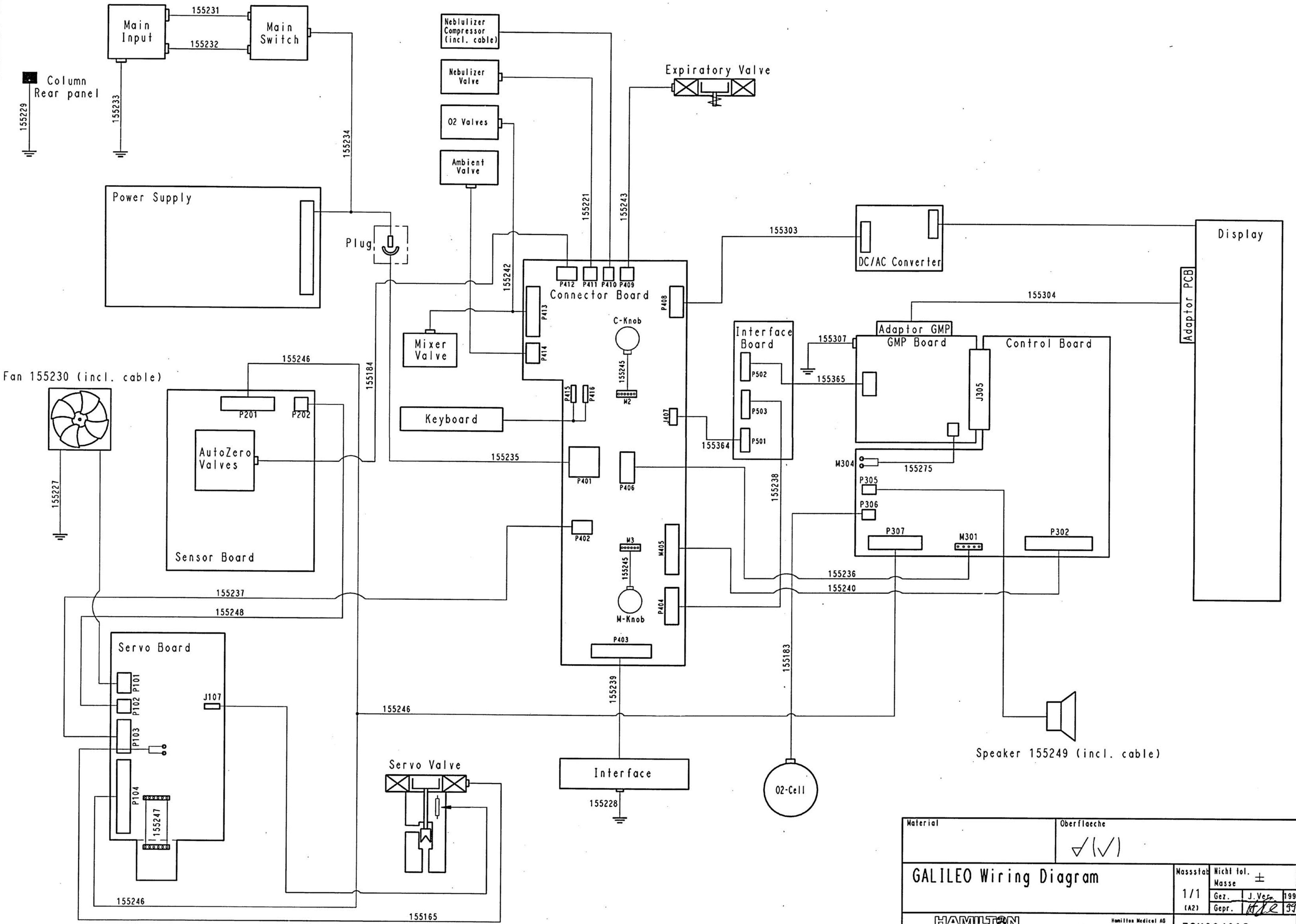
I.10.2 GMP assembly PN 155499 for Upgrade 2 GALILEOs

Schematic title and number	Description	Board revision	Schematic revision	Included in manual
Single Bord Computer 2 ZCH155499	Exploded diagram of the single board computer.	00	00	Yes

I.10.3 GMP assembly PN 396170 for Upgrade 2 GALILEOs

Note
This assembly can only function with control board PN 155461 Rev 04 and later.

No schematics currently available.



Material	Oberflaeche
	$\forall$ (√)

GALILEO Wiring Diagram

Massstab	Nicht tol. Masse	±	Blatt 1 von 1
1/1 (A2)	Gez.	J. Ver.	1996-12-10
	Gepr.	HLR	99-11-04

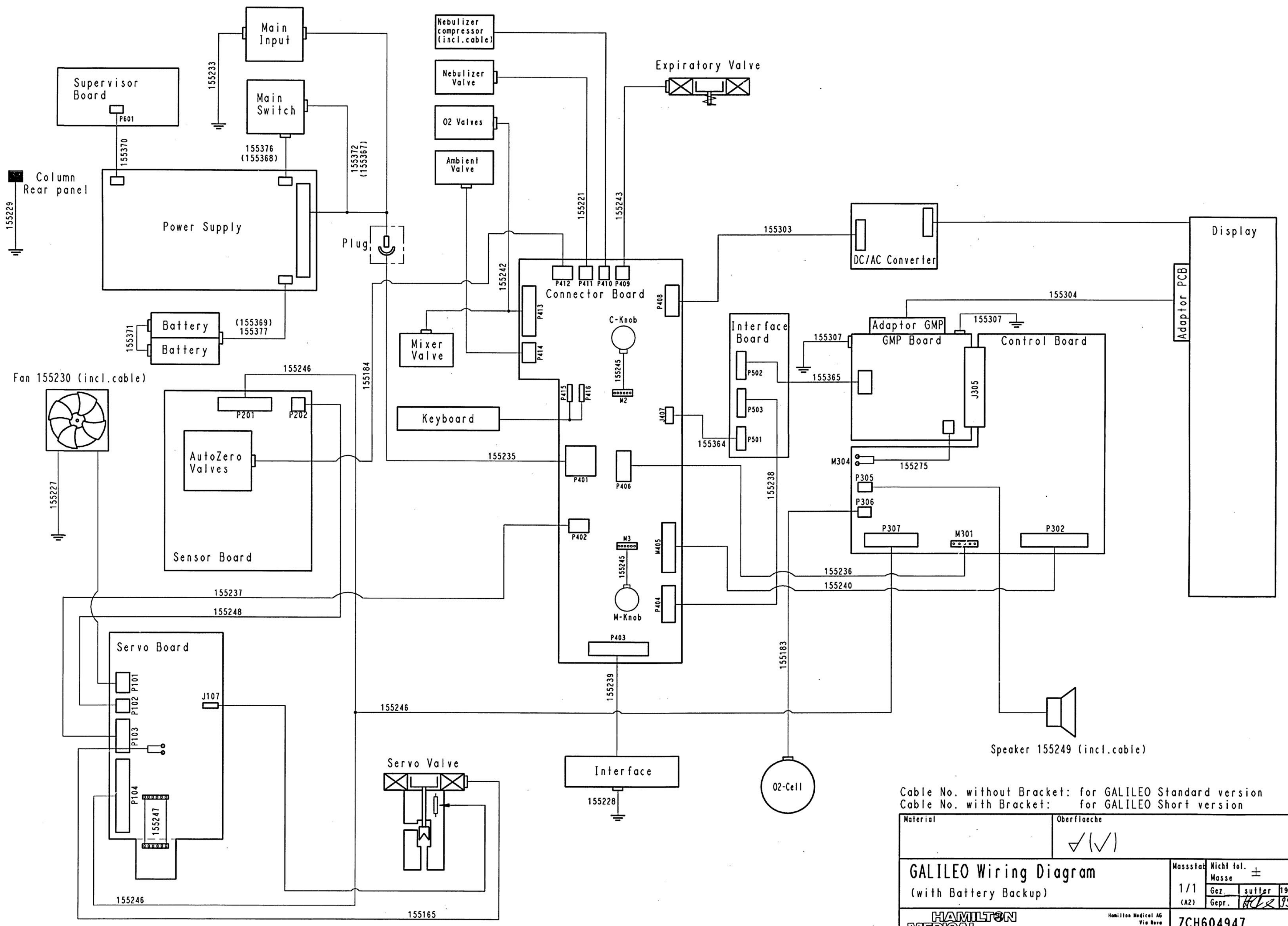
HAMILTON MEDICAL

Hamilton Medical AG
Via Nova
CH-7403 Rhäzüns

ZCH604918

Rev. 01

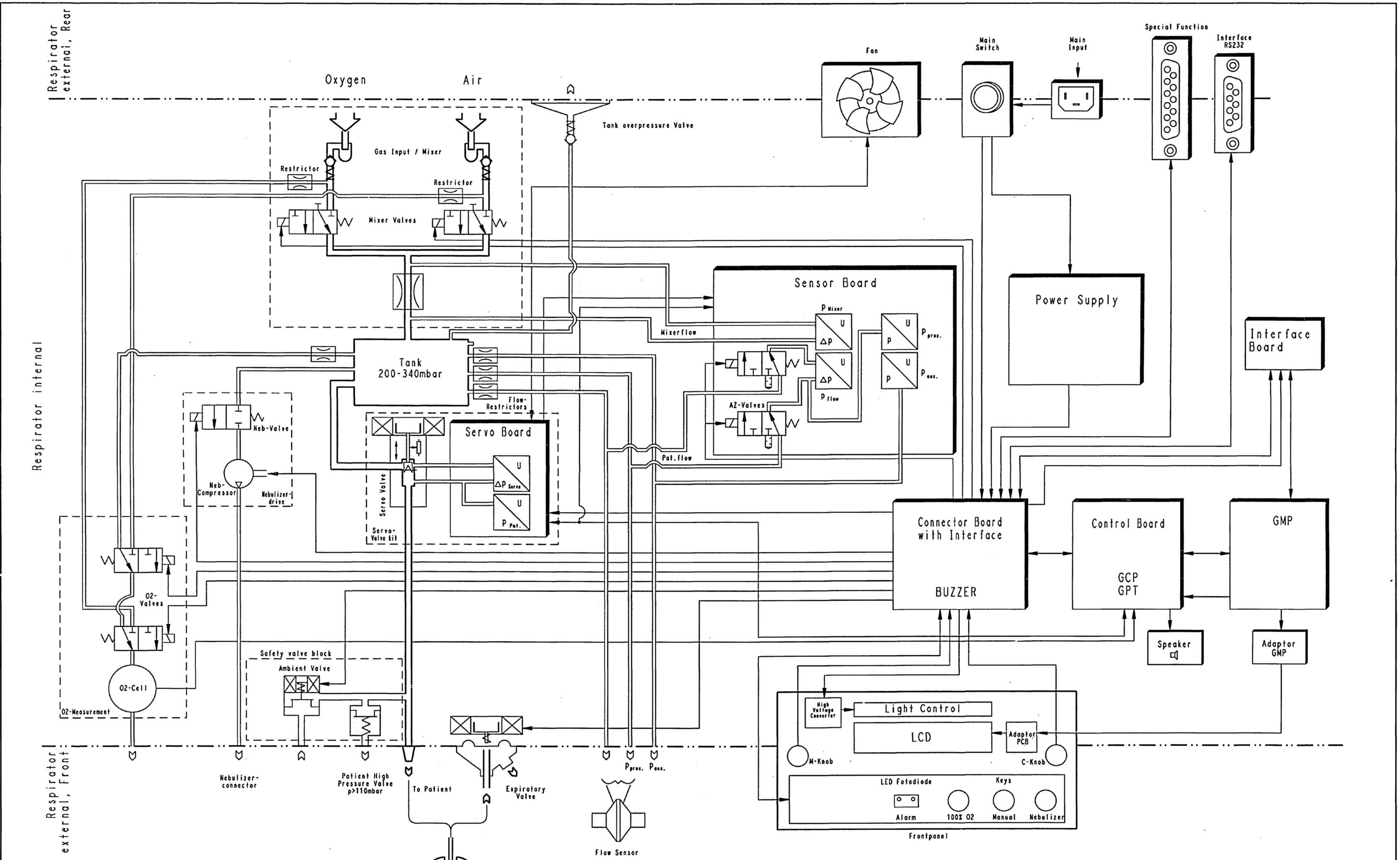
Modell Nr.	604918	Aend. Nr.	8742
Modell Rev.	1.0	Aend. Datum	1999-10-21
Objekttyp	PART	Name	sutter
Zeich. Rev.	1.1+		



Cable No. without Bracket: for GALILEO Standard version
Cable No. with Bracket: for GALILEO Short version

Material	Oberflaeche			
	$\nabla(\surd)$			
GALILEO Wiring Diagram (with Battery Backup)	Massstab 1/1 (A2)	Nicht tol. Masse ±		Blatt 1 von 1
		Gez.	sutter	1999-11-01
		Gepr.	HCL	99-11-05
HAMILTON MEDICAL — Hamilton Medical AG, Via Nova, CH-7403 Rhäzüns	ZCH604947			Rev. 00

Modell Nr.	604947	Aend. Nr.	8742
Modell Rev.	###	Aend. Datum	1999-11-01
Objekttyp	PART	Name	sutter
Zeich. Rev.	1.0+		



Material	Oberflaeche
	∇(√)

GALILEO Block Diagram

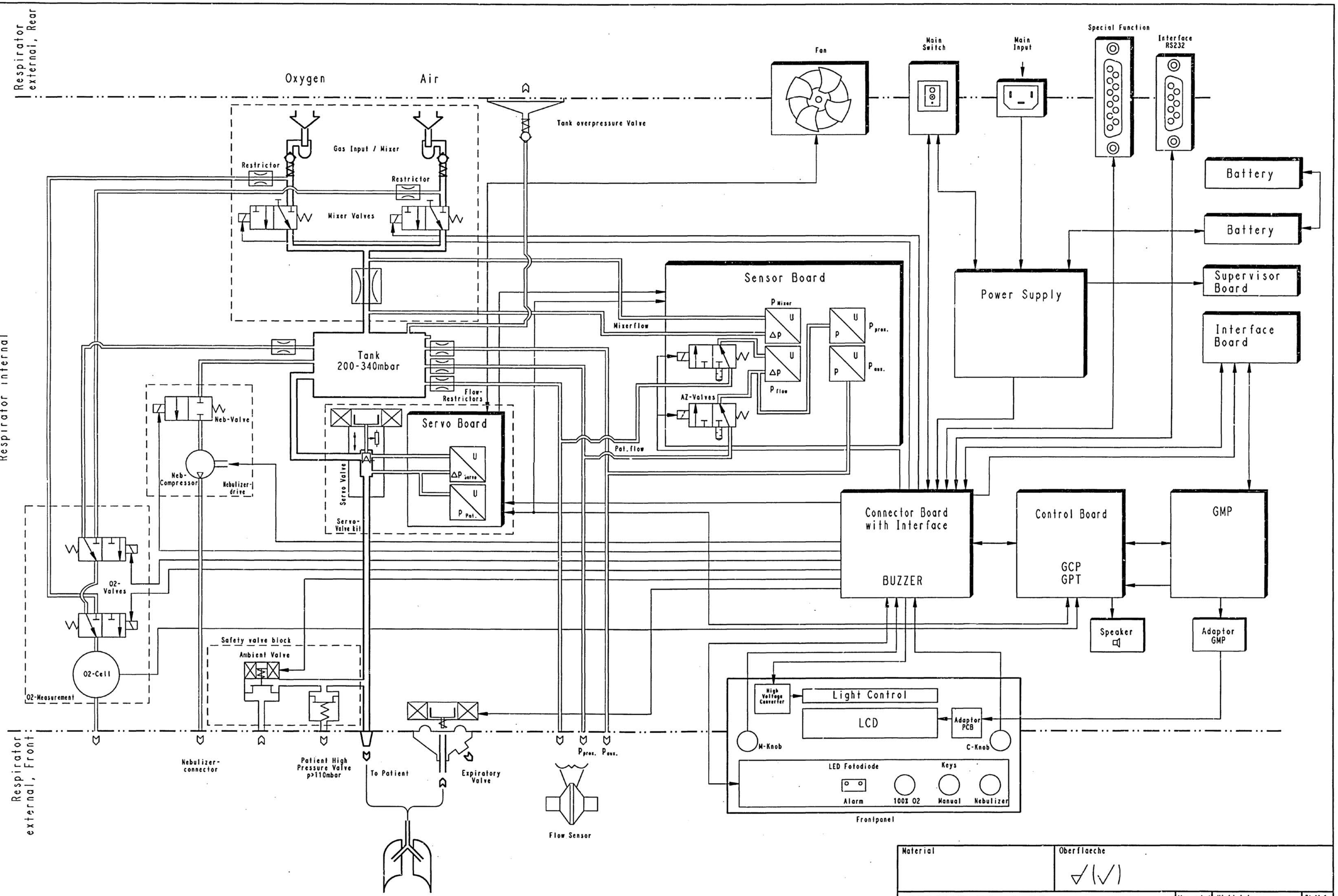
Massstab	Nicht tol. Masse	±	Blatt 1 von 1
1/1 (A2)	Gez.	J.Ver.	1996-12-10
	Gepr.	[illegible]	99-11-04
ZCH614024			Rev. 01

HAMILTON MEDICAL

Hamilton Medical AG
Via Nova
CH-7403 Rhäzüns

Plot Abs.: Gian Andrea Sutter 1999-11-04T16:28

Modell Nr.	614024	Aend. Nr.	8742
Modell Rev.	1.0	Aend. Datum	1999-10-21
Objekttyp	PART	Name	sutter
Zeich. Rev.	1.1+		



Material	Oberflaeche
	∇ (√)

GALILEO Block Diagram
(with Battery Backup)

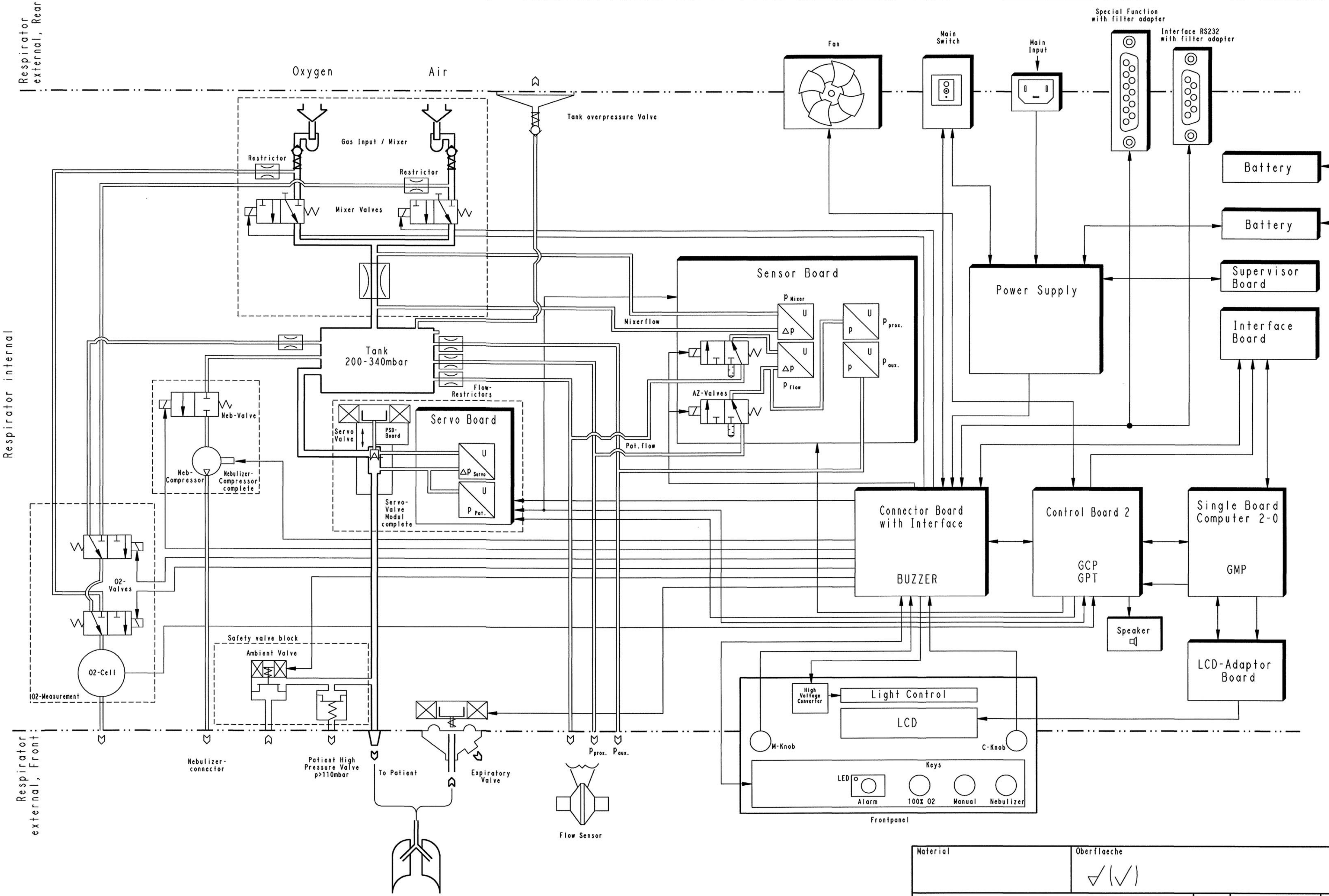
Massstab	Nicht tol. Masse	±	Blatt 1 von 1
1/1 (A2)	Gez.	sutter	1999-11-01
	Gepr.	[illegible]	99-11-04

HAMILTON MEDICAL — Hamilton Medical AG, Via Nova, CH-7403 Rhäzüns

ZCH614201 — Rev. 00

Plot Abs.: Gian Andrea Sutter 1999-11-04T18:35

Modell Nr.	614201	Aend. Nr.	8742
Modell Rev.		Aend. Datum	1999-11-01
Objekttyp	PART	Name	sutter
Zeich. Rev.			



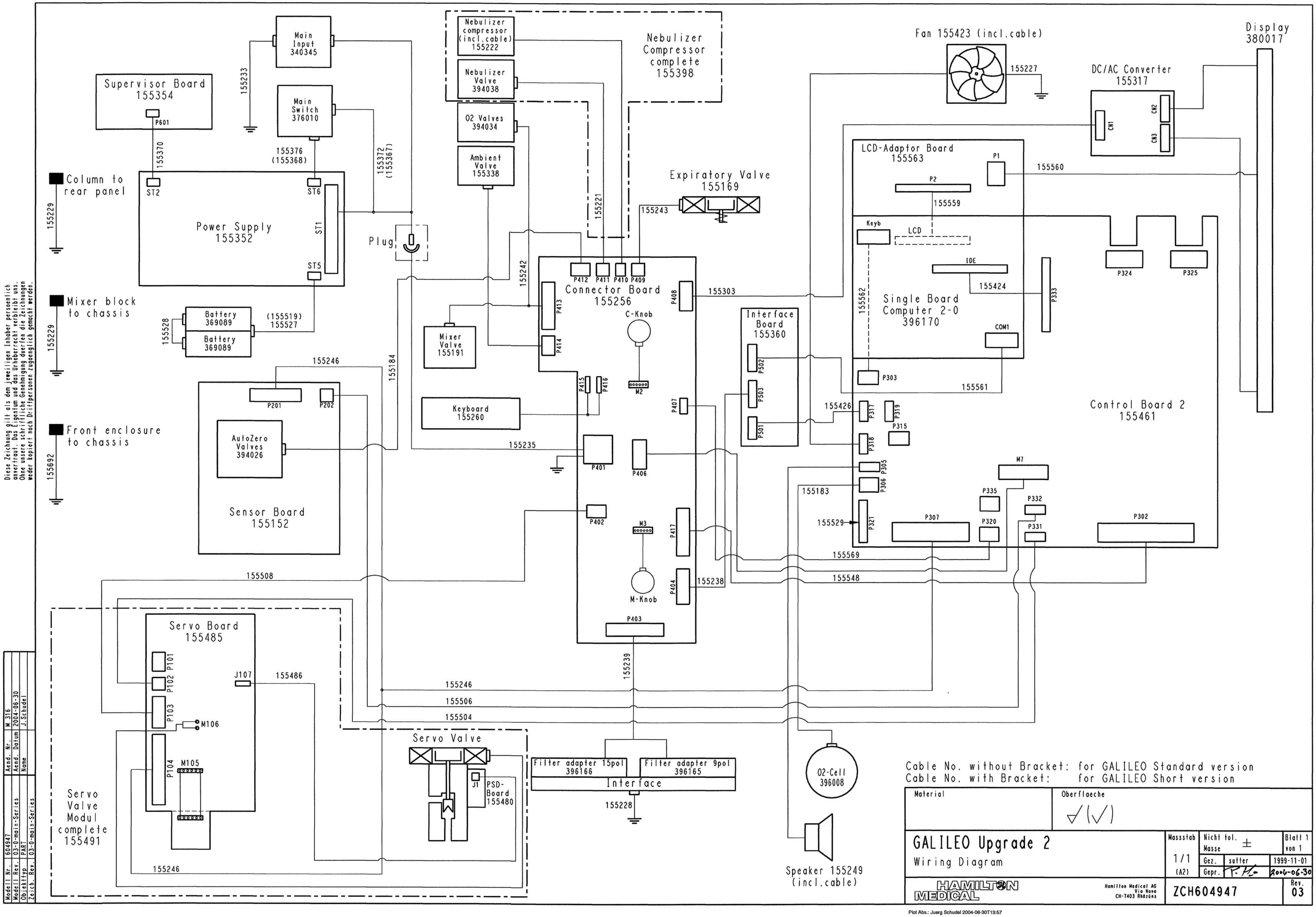
Material	Oberflaeche

GALILEO Upgrade 2	Massstab	Nicht tol. Masse ±	Blatt 1 von 1
Block Diagram	1/1 (A2)	Gez. sutter	1999-11-01
		Gepr.	2003-06-26
HAMILTON MEDICAL — Hamilton Medical AG, Via Nova, CH-7403 Rhäzüns	ZCH614201		Rev. 02

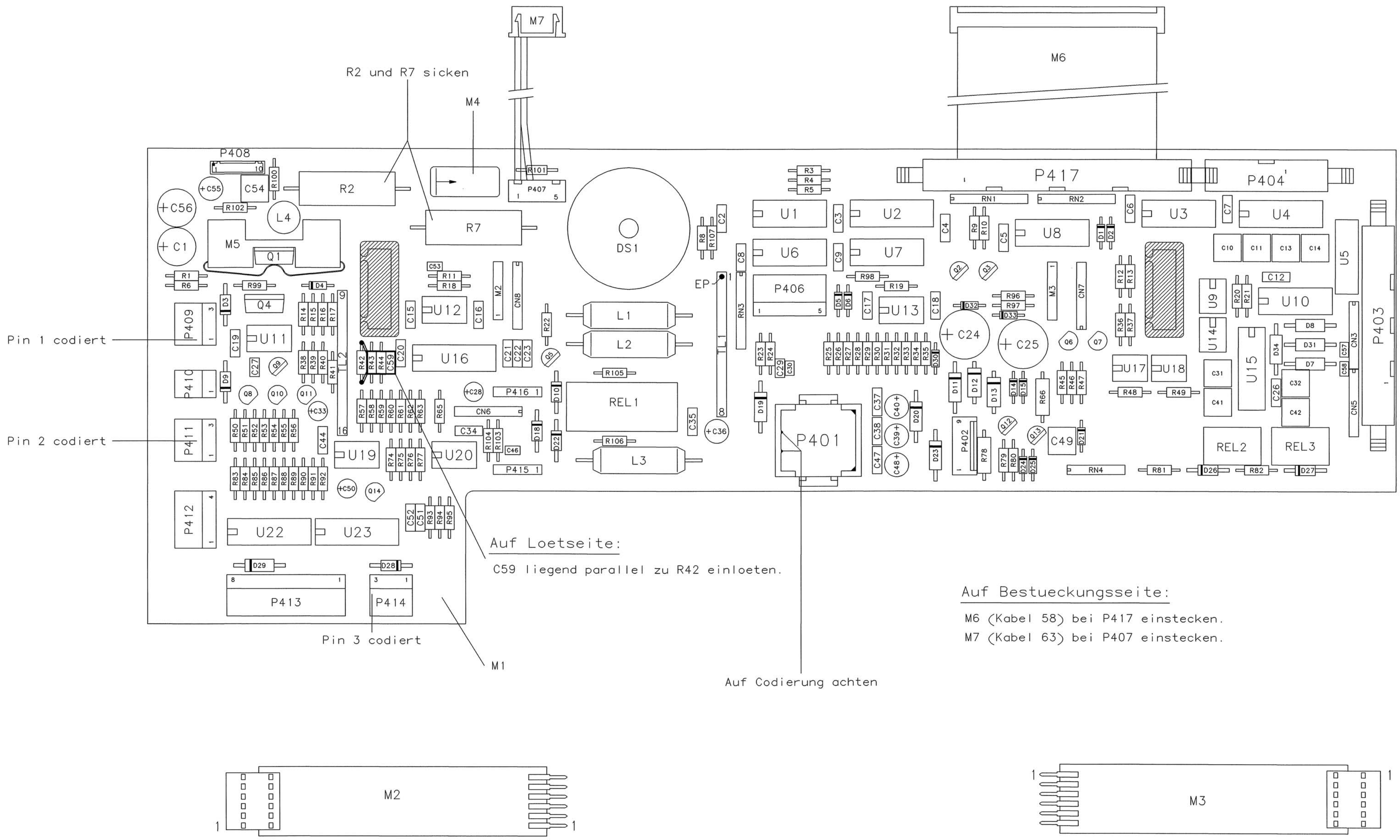
Plot Abs.: Juerg Schudel 2003-06-25T16:45

Aend. Nr.	M 147
Aend. Datum	2003-06-25
Name	J.Schudel

Modell Nr.	614201
Modell Rev.	1.0
Objekttyp	PART
Zeich. Rev.	1.1



Display 380017
DC/AC Converter 155317
CN1
CN2
CN3
Fan 155423 (incl.cable)
155227
LCD-Adaptor Board 155563
P1
P2
155560
155559
LCD
Keyb
Single Board Computer 2-0 396170
IDE
155424
COM1
155562
155561
Control Board 2 155461
P324
P325
P333
P303
P317
P319
P315
P318
P305
P306
P321
P307
P320
P335
P332
P331
M7
P302
155426
155183
155529
155569
155548
Interface Board 155360
P502
P503
P501
155303
Expiratory Valve 155169
155243
Nebulizer Compressor complete 155398
Nebulizer compressor (incl.cable) 155222
Nebulizer Valve 394038
O2 Valves 394034
Ambient Valve 155338
155221
Connector Board 155256
P412
P411
P410
P409
P408
P413
P414
C-Knob
M2
P415
P416
P407
P401
P406
P402
M3
P417
P404
M-Knob
P403
155238
155242
155235
Mixer Valve 155191
Keyboard 155260
155184
Main Input 340345
155233
Main Switch 376010
155376 (155368)
155372 (155367)
Supervisor Board 155354
P601
155370
Power Supply 155352
ST2
ST6
ST1
ST5
Plug
Battery 369089
Battery 369089
(155519) 155527
155528
Column to rear panel
155229
Mixer block to chassis
155229
Front enclosure to chassis
155692
Sensor Board 155152
P201
P202
AutoZero Valves 394026
155246
155508
Servo Board 155485
P101
P102
P103
P104
J107
M106
M105
155486
155246
155506
155504
155239
Servo Valve
J1
PSD-Board 155480
Servo Valve Modul complete 155491
155246
Filter adapter 15pol 396166
Filter adapter 9pol 396165
Interface
155228
O2-Cell 396008
Speaker 155249 (incl.cable)
Cable No. without Bracket: for GALILEO Standard version
Cable No. with Bracket: for GALILEO Short version
Material
Oberflaeche
GALILEO Upgrade 2
Wiring Diagram
Massstab 1/1 (A2)
Nicht tol. Masse ±
Gez. sutter 1999-11-01
Gepr. 2004-06-30
Blatt 1 von 1
HAMILTON MEDICAL
Hamilton Medical AG Via Nova CH-7403 Rhäzüns
ZCH604947
Rev. 03
Modell Nr. 604947
Modell Rev. 03-0-main-Series
Objekttyp PART
Zeich. Rev. 03-0-main-Series
Aend. Nr. M 316
Aend. Datum 2004-06-30
Name J.Schudel
Diese Zeichnung gilt als dem jeweiligen Inhaber persoenlich anvertraut. Das Eigentum und das Urheberrecht verbleibt uns. Ohne unsere schriftliche Genehmigung duerfen die Zeichnungen weder kopiert noch Drittpersonen zugaenglich gemacht werden.
Plot Abs.: Juerg Schudel 2004-06-30T13:57



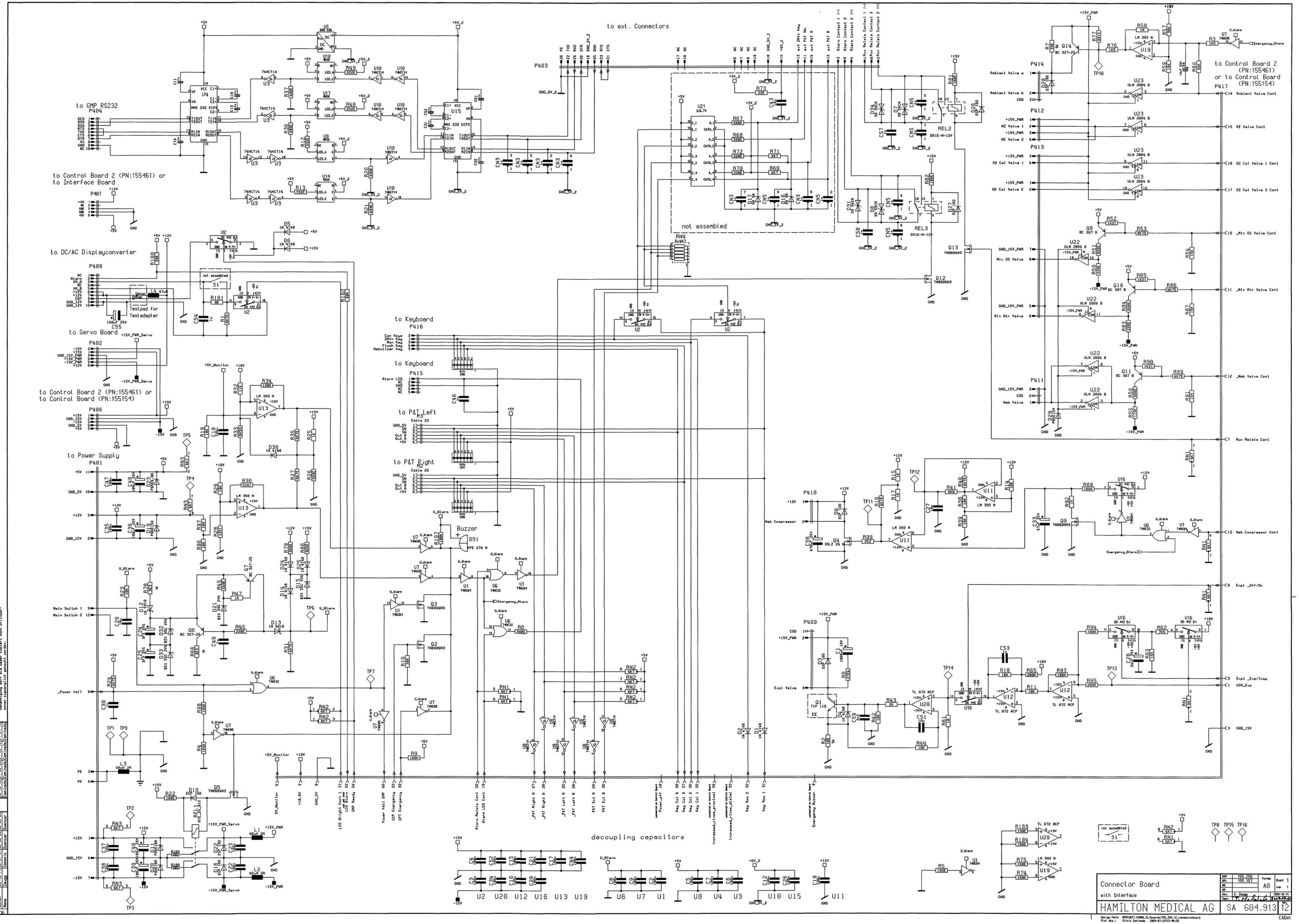
Revision	06	07	08	09	10	11	12	13
Aend.Nr.	8591	8736	M26	M78	M70	M94	M123	M316
Datum	99-04-27	99-10-14	02-01-31	02-08-05	02-08-05	02-09-25	03-01-22	04-06-18
Name	M. Lutz	Zaugg	Camenis	Duenser	Duenser	Duenser	Caminada	Caminada

Aenderg.

Connector Board mit Interface	Massstab 2:1 bei A1	BPL	155.157	Blatt 1
		SA	604.913	von 1
		Gez.	G. Zaugg	1999-10-14
		Gepr.	[illegible]	2004-06-18
HAMILTON MEDICAL AG		BSP	155.256	13

/user/gamma_el/boards/155_256_11_connectorboard
Silvio Caminada 2004-06-18T08:58:23

CADel

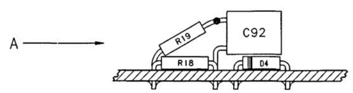

to ext. Connectors
to GMP RS232
P404
to Control Board 2 (PN:155461) or
to Interface Board
P407
to DC/AC Displayconverter
P408
Testpad for
Testadapter
not assembled
to Servo Board
P402
to Control Board 2 (PN:155461) or
to Control Board (PN:155154)
P406
to Power Supply
P401
to Keyboard
P416
to Keyboard
P415
to P&T Left
to P&T Right
Buzzer
decoupling capacitors
to Control Board 2
(PN:155461)
or to Control Board
(PN:155154)
P417
Connector Board
with Interface
HAMILTON MEDICAL AG
SA 604.913
12

Folgende Leiterbahnen muessen durchtrennt werden:

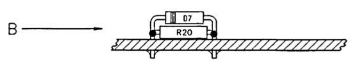
Bestueckungsseite:
Beim IC U11 Leiterbahn zu Pin3
Die Leiterbahn zwischen Pin13
und Durchkontaktierung muss
bestehen bleiben!

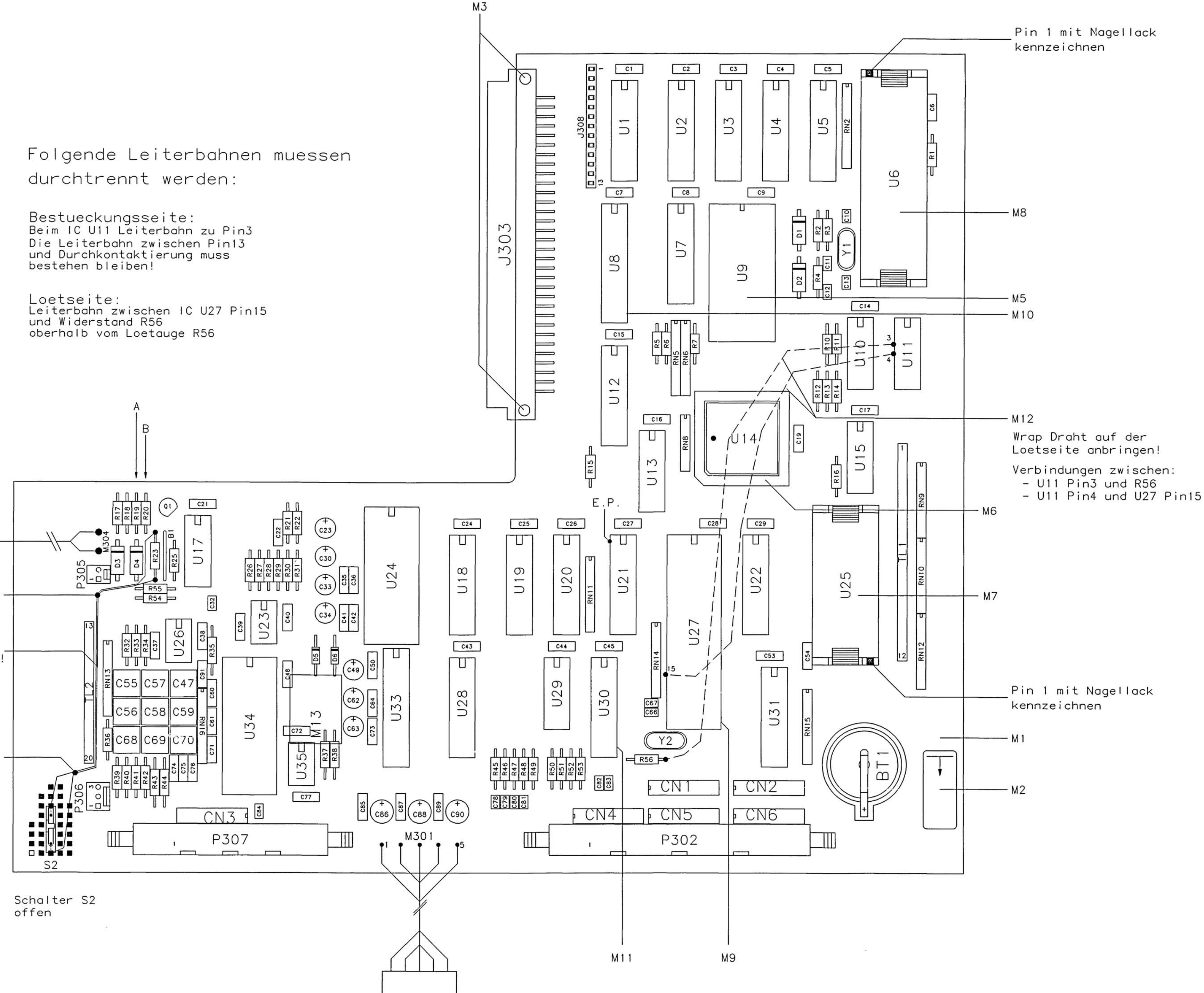
Loetseite:
Leiterbahn zwischen IC U27 Pin15
und Widerstand R56
oberhalb vom Loetauge R56

C92 = 1uF/63V (322.121)
R19 = 664 E (334.396)



D7 = 1N5819 (312.018)

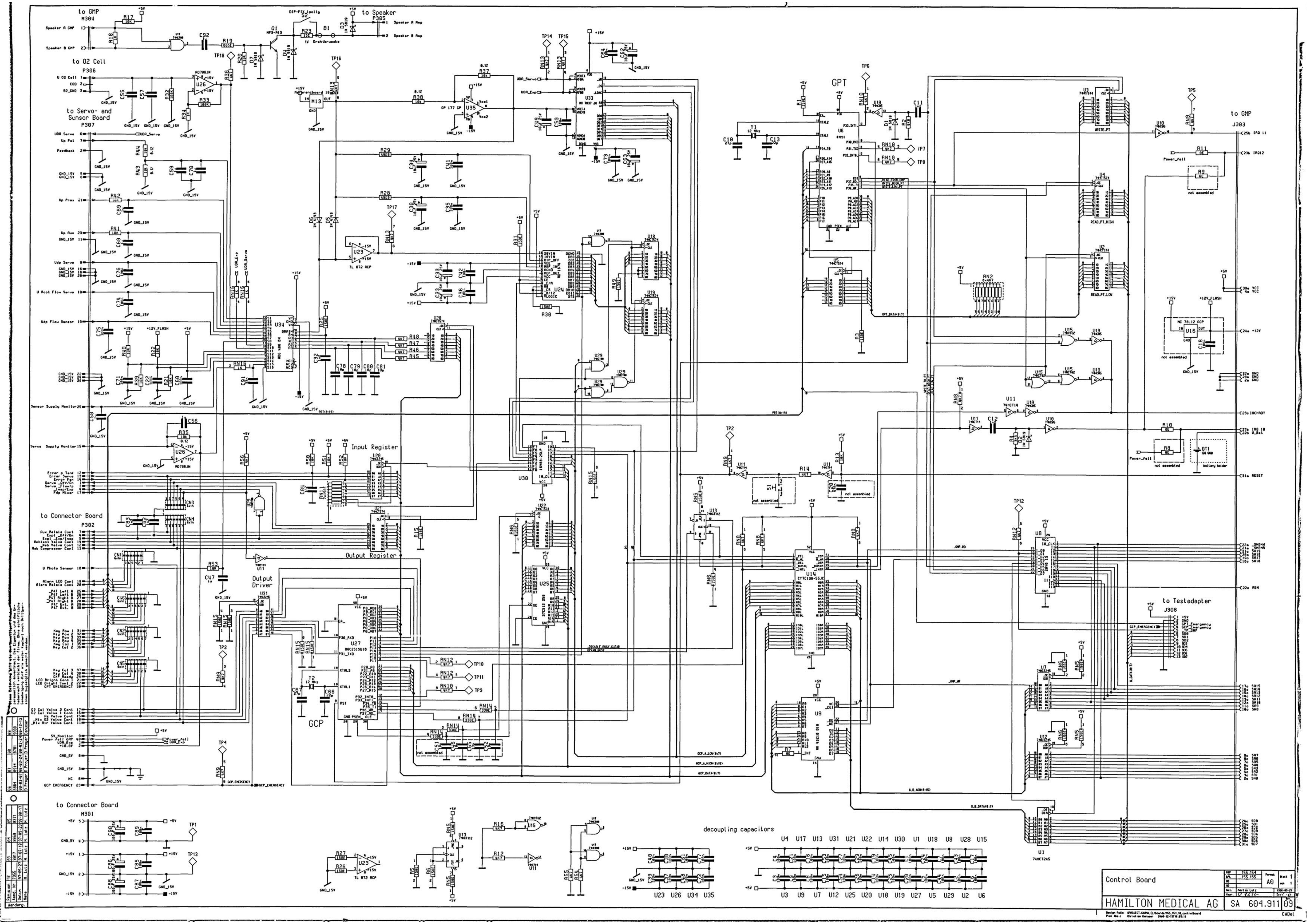


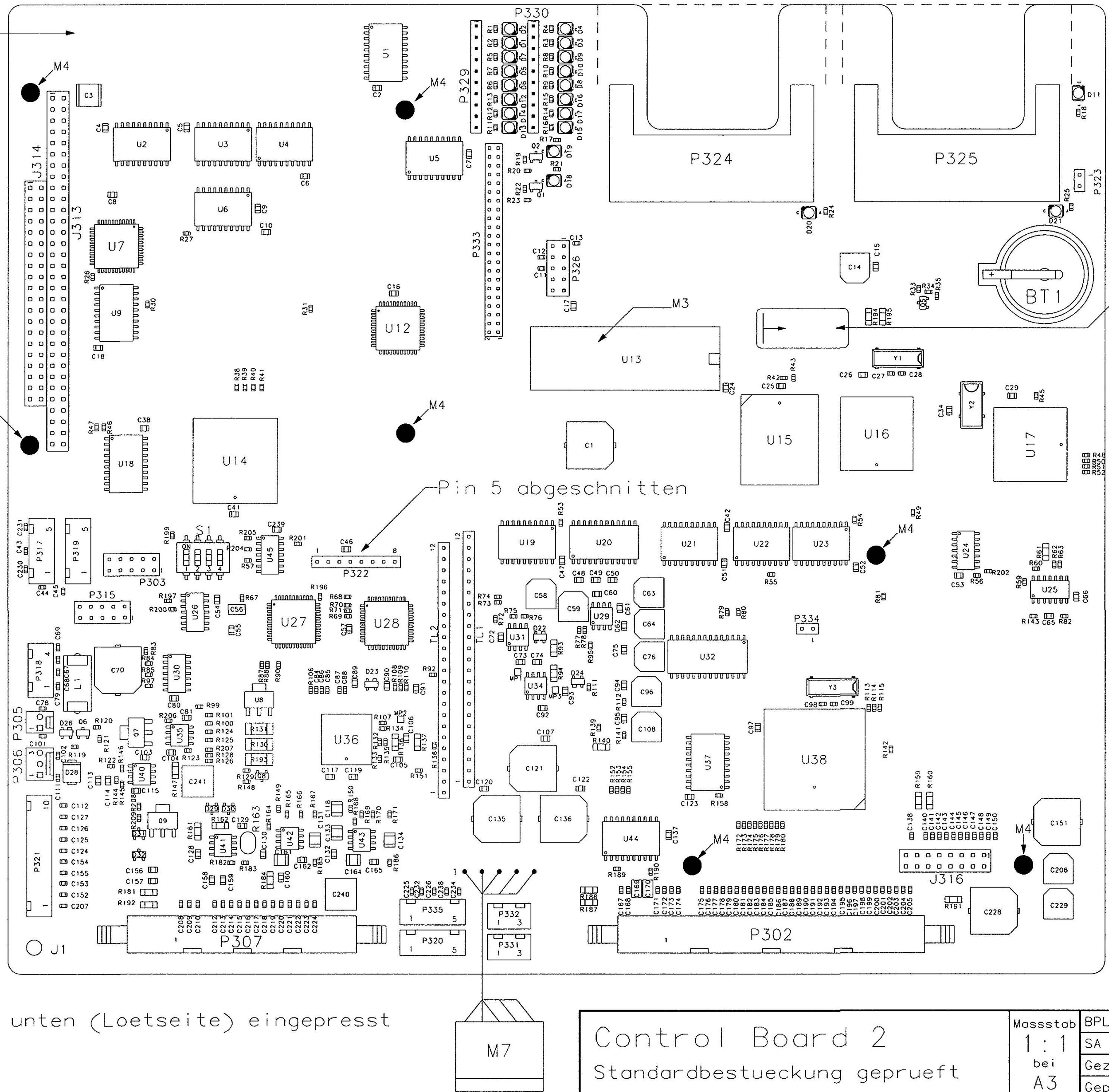


Control Board	Massstab % bei A1	BPL	155.155	Blatt 1
		SA	604.911	von 1
		Gez.	Martin Lutz	1995-03-25
		Gepr.	D. [illegible]	2000-12-14
HAMILTON MEDICAL AG		BSP	155.154	08

Design Path: /user/gamma_el/boards/155_154_10_controlboard
Plot Abs: Christian Danuser 2000-12-13T16:43:50
CADel

Aenderg.	Revision	01	02	03	04	05	06	07	08
	Aend.Nr.	7784	7824	7955	8371	8884	8914	8781	9088
	Datum	96-12-09	97-01-22	97-05-28	98-08-18	00-03-07	00-03-24	00-03-24	00-12-13
	Name	M. Lutz	M. Lutz	M. Lutz	M. Lutz	D.Proyer	D.Proyer	D.Proyer	Danuser


to GMP
M304
to O2 Cell
P306
to Servo- and
Sunsor Board
P307
to Connector Board
P302
to Connector Board
M301
to Speaker
P305
to GMP
J303
to Testadapter
J308
GPT
GCP
Input Register
Output Register
Output
Driver
decoupling capacitors
Control Board
HAMILTON MEDICAL AG
SA 604.911 09
CADel



M4: Gewindebolzen von unten (Loetseite) eingepresst

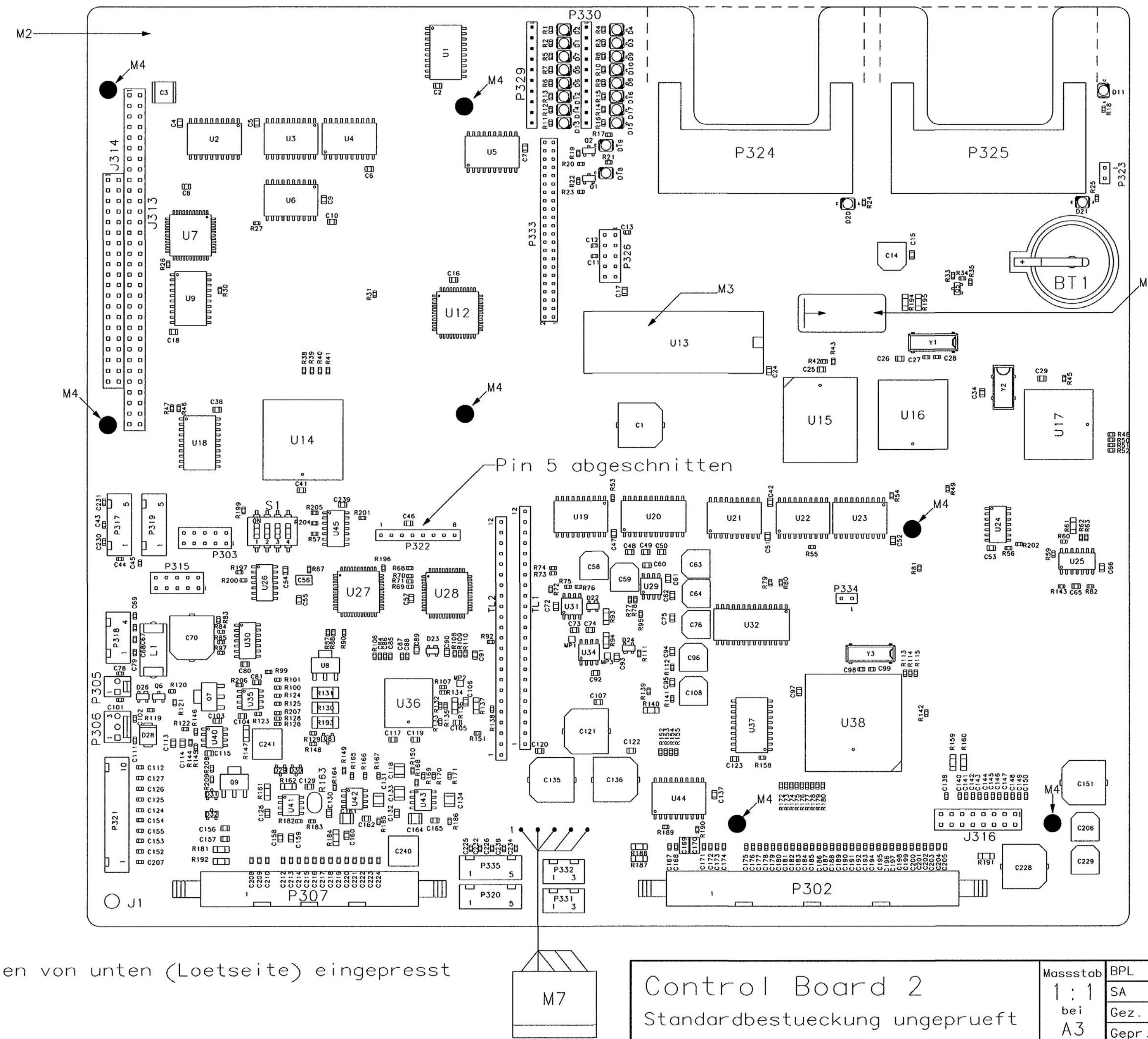
Control Board 2	Massstab 1 : 1 bei A3	BPL	155.463	Blatt	1
Standardbestueckung geprueft		SA	604.986	von	2
		Gez.	W Duenser		2002-10-01
		Gepr.	S.Caminada		2004-10-13
HAMILTON MEDICAL AG		BSP	155.461	04	

Design Path /user/gamma_el/boards/155_461_05_controlboard_10548
Plot Abs Silvio Caminada 2004-10-13T11 55:56

CADel

Revision	01	02	03	04
Aend.Nr.	M98	M120	M241	10548
Datum	02-10-24	03-01-21	03-12-02	04-10-13
Name	etscharn	etscharn	Caminada	Caminada

Aenderg



M4: Gewindebolzen von unten (Loetseite) eingepresst

Aenderg.							
Revision	01	02	03	04			05
Aend.Nr.	M5	M93	M98	M120			M241
Datum	01-12-06	02-10-01	02-10-24	03-01-21			03-12-02
Name	DC	Duenser	etscharn	etscharn			Caminada

Control Board 2

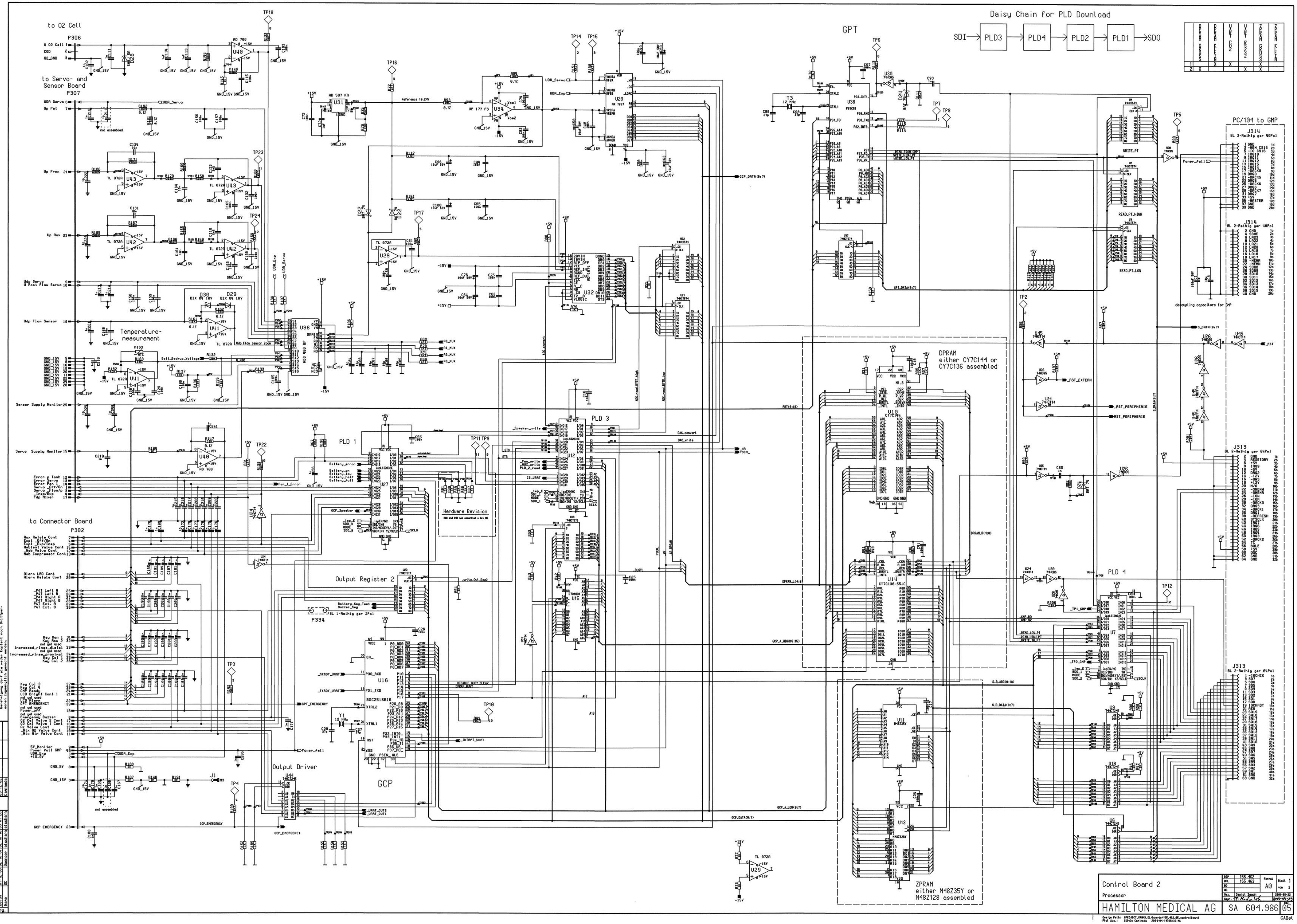
Standardbestueckung ungeprueft

Massstab	BPL	155.463	Blatt	1
1 : 1	SA	604.986	von	2
bei	Gez.	Daniel Zaech		2001-08-22
A3	Gepr.	P. Hodalch		2004-04-19

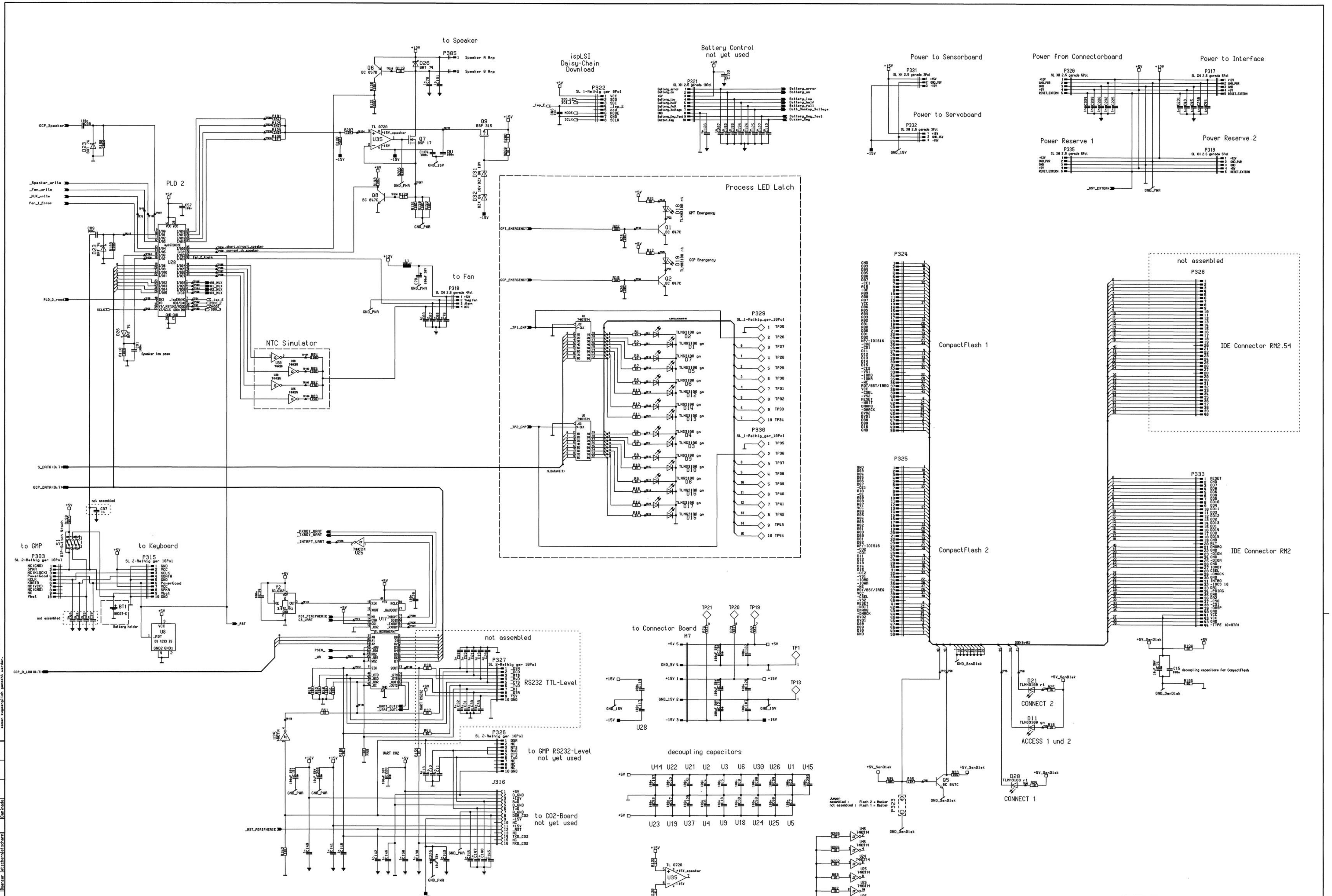
HAMILTON MEDICAL AG BSP 155.462 05

Design Path: /user/gamma_el/boards/155_462_05_controlboard
Plot Abs: Silvio Caminada 2004-04-14T08:34:30

CADel



Daisy Chain for PLD Download
SDI → PLD3 → PLD4 → PLD2 → PLD1 → SDO
GPT
GCP
PLD 1
PLD 3
PLD 4
to O2 Cell
to Servo- and Sensor Board
to Connector Board
Temperature-measurement
Output Register 2
Output Driver
Hardware Revision
PC/104 to GMP
DPRAM either CY7C144 or CY7C136 assembled
ZPRAM either M48Z35Y or M48Z128 assembled
Control Board 2
Processor
HAMILTON MEDICAL AG
SA 604.986 05

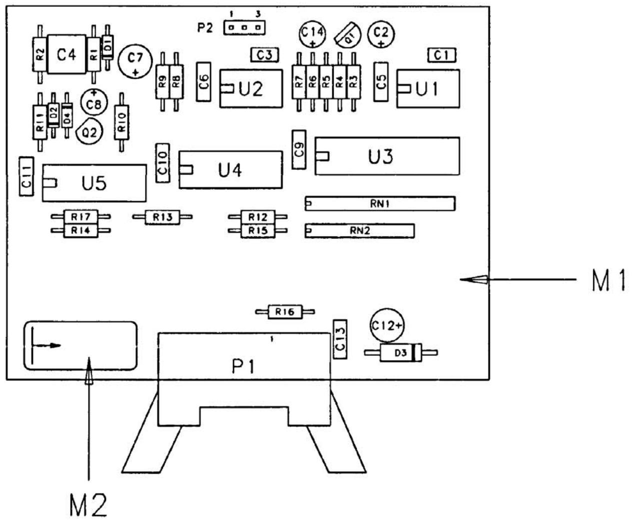


Control Board 2	BSP	155.462	Format	Blatt 2	
Connectors	BPL	155.463	A0	von 2	
	Gez.	Daniel Zaech		2001-08-22	
HAMILTON MEDICAL AG	SA 604.986			Rev. 05	

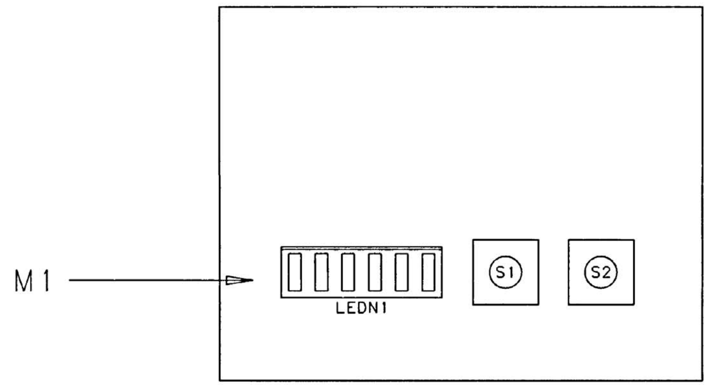
Design Path: $PROJECT_GAMMA.EL/boards/155.462_05.controlboard
Plot Aus.: Silvio Caminada 2004-01-14T08:31:26

CADel

Aenderg.		
Revision	01	02
Aend.Nr.		8736
Datum	99-07-06	99-10-07
Name	M. Lutz	Zaugg



Ansicht auf die Bestueckungsseite

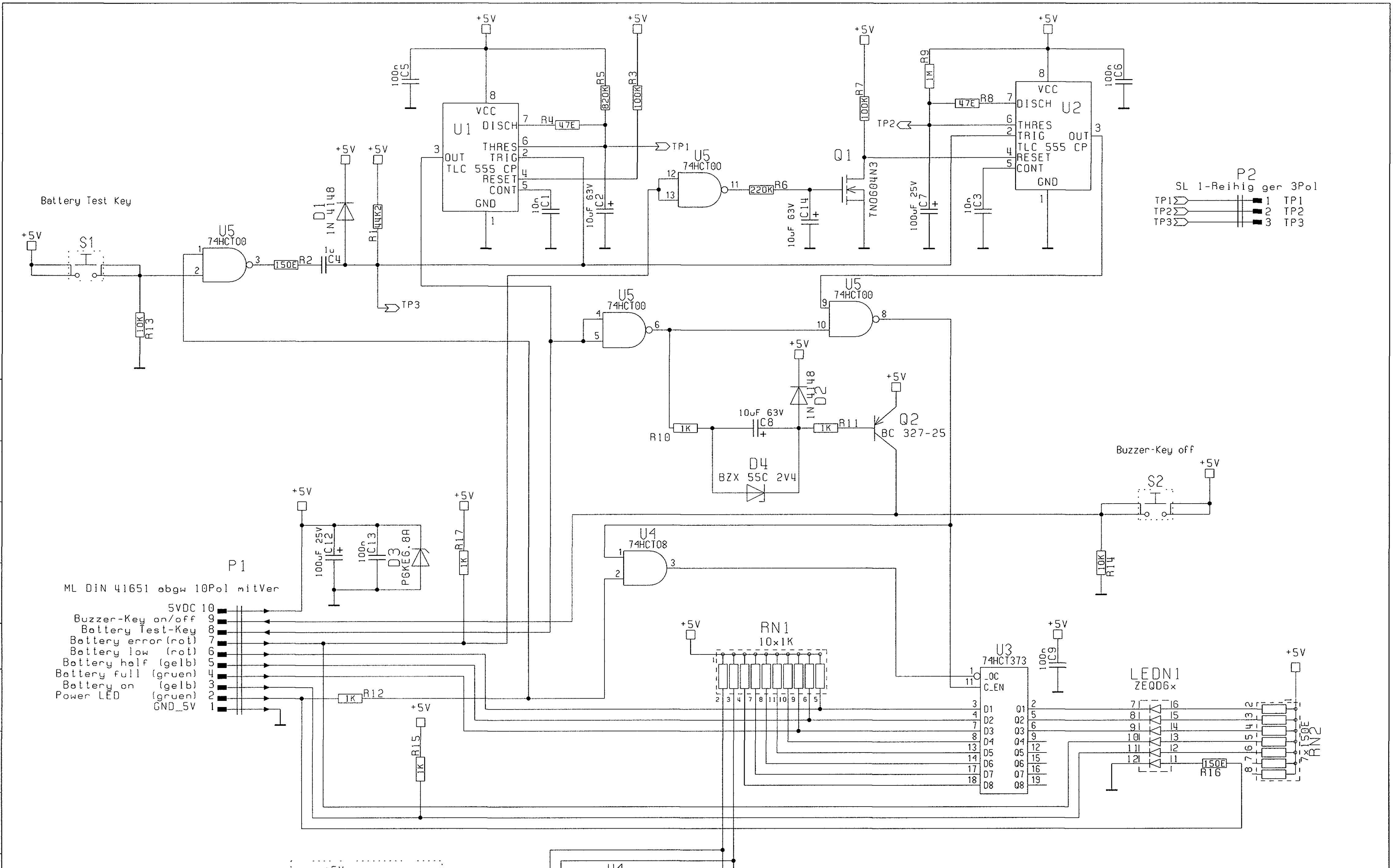


Ansicht auf die Loetseite

Ueberwachungs-Board	Massstab 1 : 1 bei A3	BPL	155.355	Blatt	1
		SA	604.944	von	1
		Gez.	G. Zaugg		1999-10-07
		Gepr.			1999-10-07
HAMILTON MEDICAL AG		BSP 155.354			Rev. 02

Design Path: /user/gamma_el/boards/155_354_02_ueberwachungs-board
Plot Abs: Gian-Duri Zaugg 1999-10-07T13:56:38

CADel



Revision	01	02	03	04
Aend. Nr		8736	M242	M310
Datum	99-07-06	99-10-07	04-02-23	04-07-19
Name	M. Lutz	Zaugg	Caminada	Caminada

Aenderg.

Ueberwachungs-Board

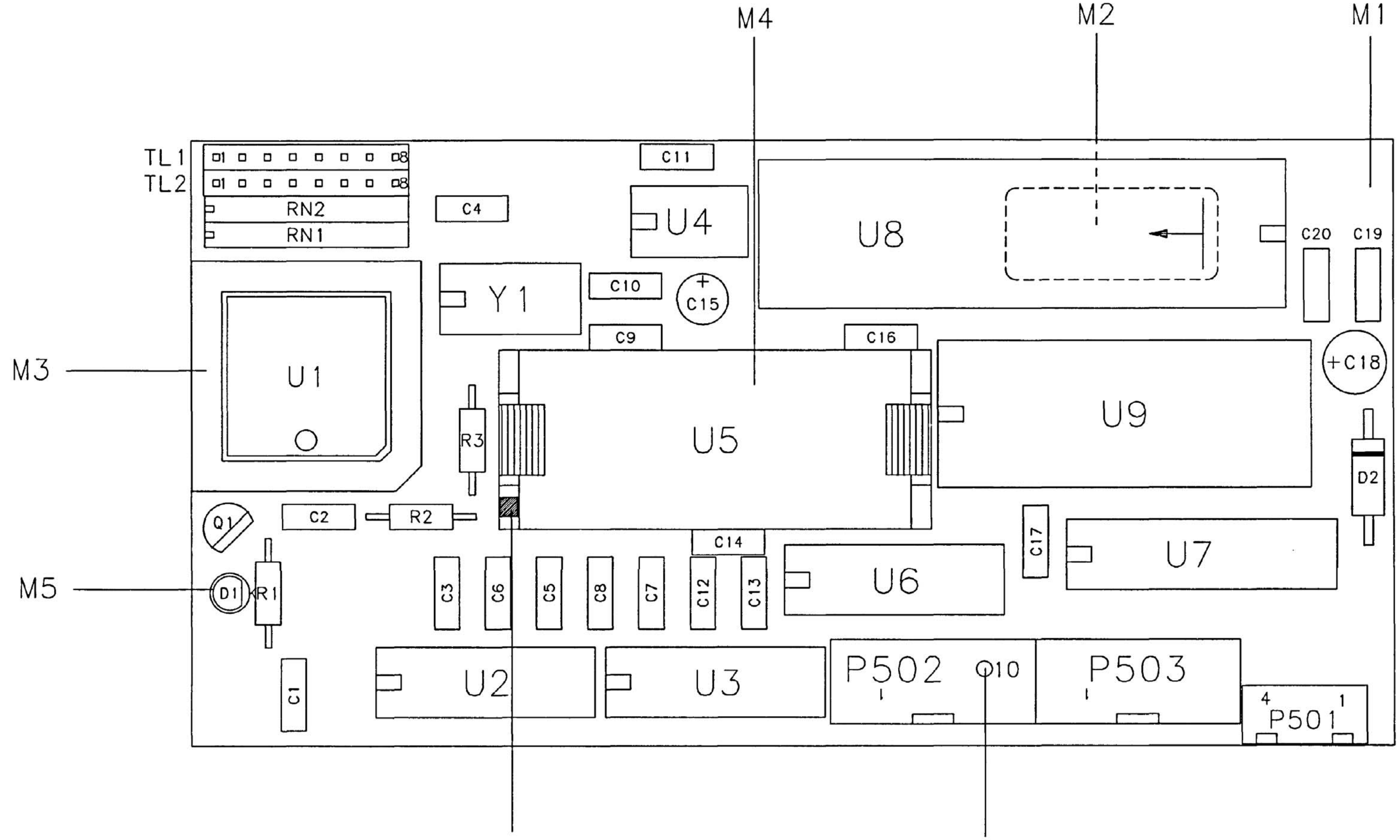
BSP	155.354	Format	Blatt 1
BPL	155.355	A3	von 1
BD			
WD			
Gez.	G Zaugg		1999-10-07
Gepr	T. Hodalek		2004-07-21

HAMILTON MEDICAL AG

SA 604.944 Rev. 04

Design Path $PROJECT_GAMMA_EL/boards/155_354_04_ueberwachungs-board
Plot Abs Silvio Caminada 2004-07-21T13 43 48

CADel



Pin 1 mit Nagellack kennzeichnen

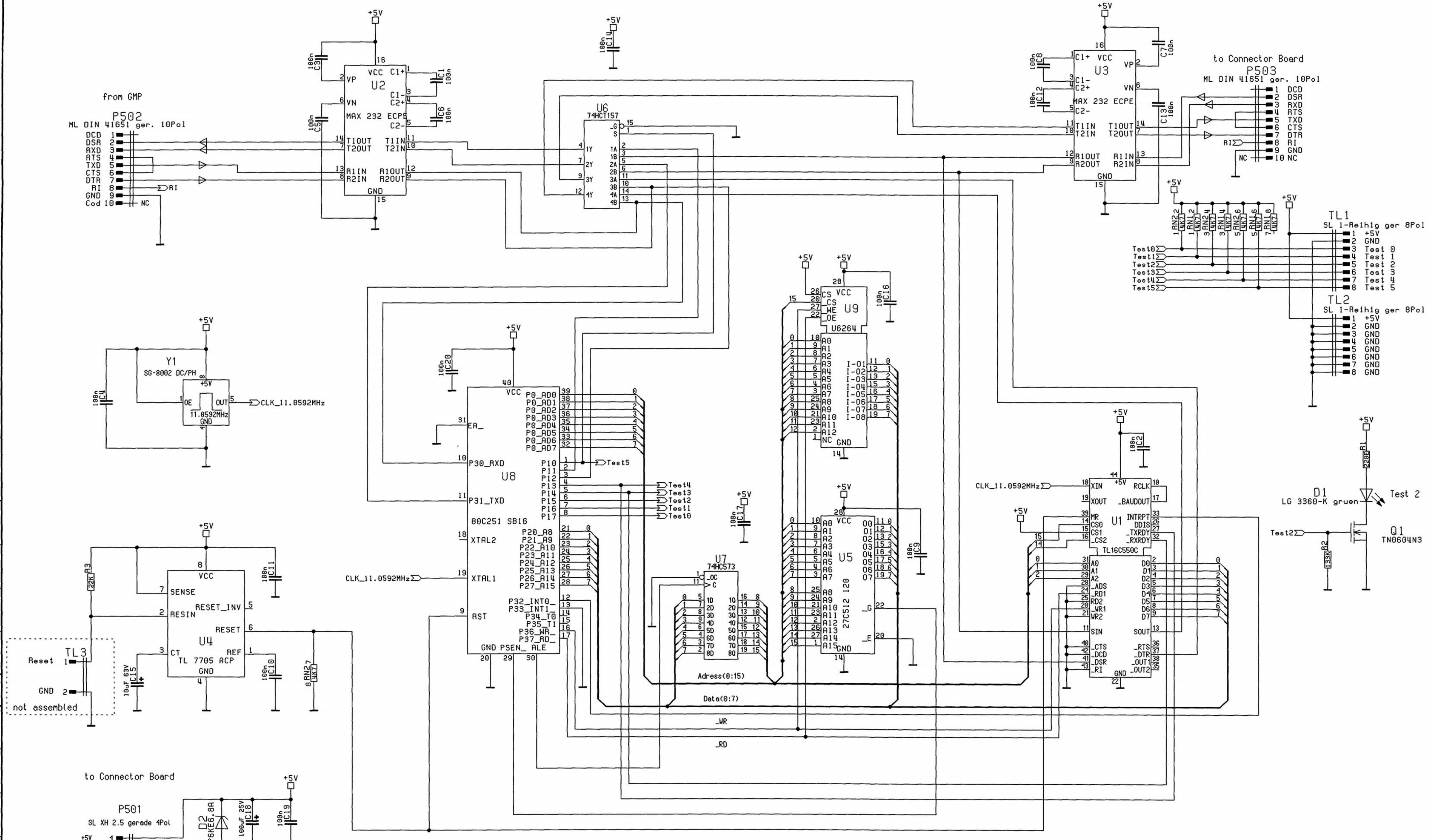
Pin 10 mit Abdrehwerkzeug entfernen (Harting 0999.000.0133)

Aenderg.				
Revision				
Aend.Nr.				
Datum				
Name				

Interface Board	Massstab 2 : 1 bei A3	BPL	155.361	Blatt	1
		SA	604.934	von	1
		Gez.	Martin Lutz		1998-11-20
		Gepr.	G. Durisch		28.1.99
HAMILTON MEDICAL AG		BSP 155.360		Rev.	00

Design Path: /user/gamma_el/boards/155_360_00_interfaceboard
Plot Abs: Martin Lutz 1999-01-28T07:42:56

CADel



Revision	01	02	03
Aend. Nr.	M62	M242	M310
Datum	02-08-28	04-02-23	04-07-19
Name	ZOBRIST	Caminada	Caminada

Aenderg.

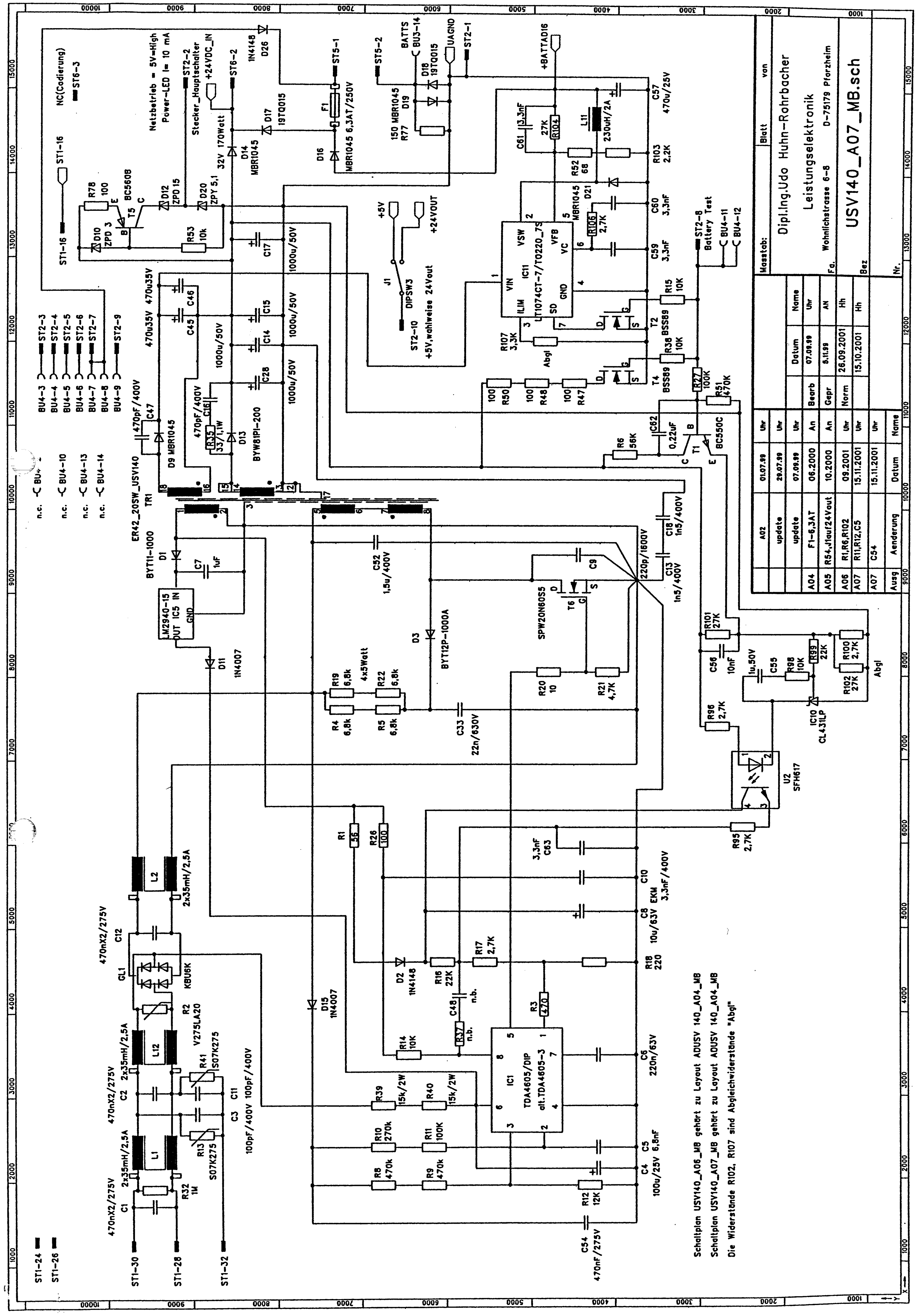
Interface Board

BSP	155.360	Format	Blatt 1
BPL	155.361	A2	von 1
BD			
WD			
Gez.	Martin Lutz		1998-11-23
Gepr.	R. Hudolet		2004-07-21

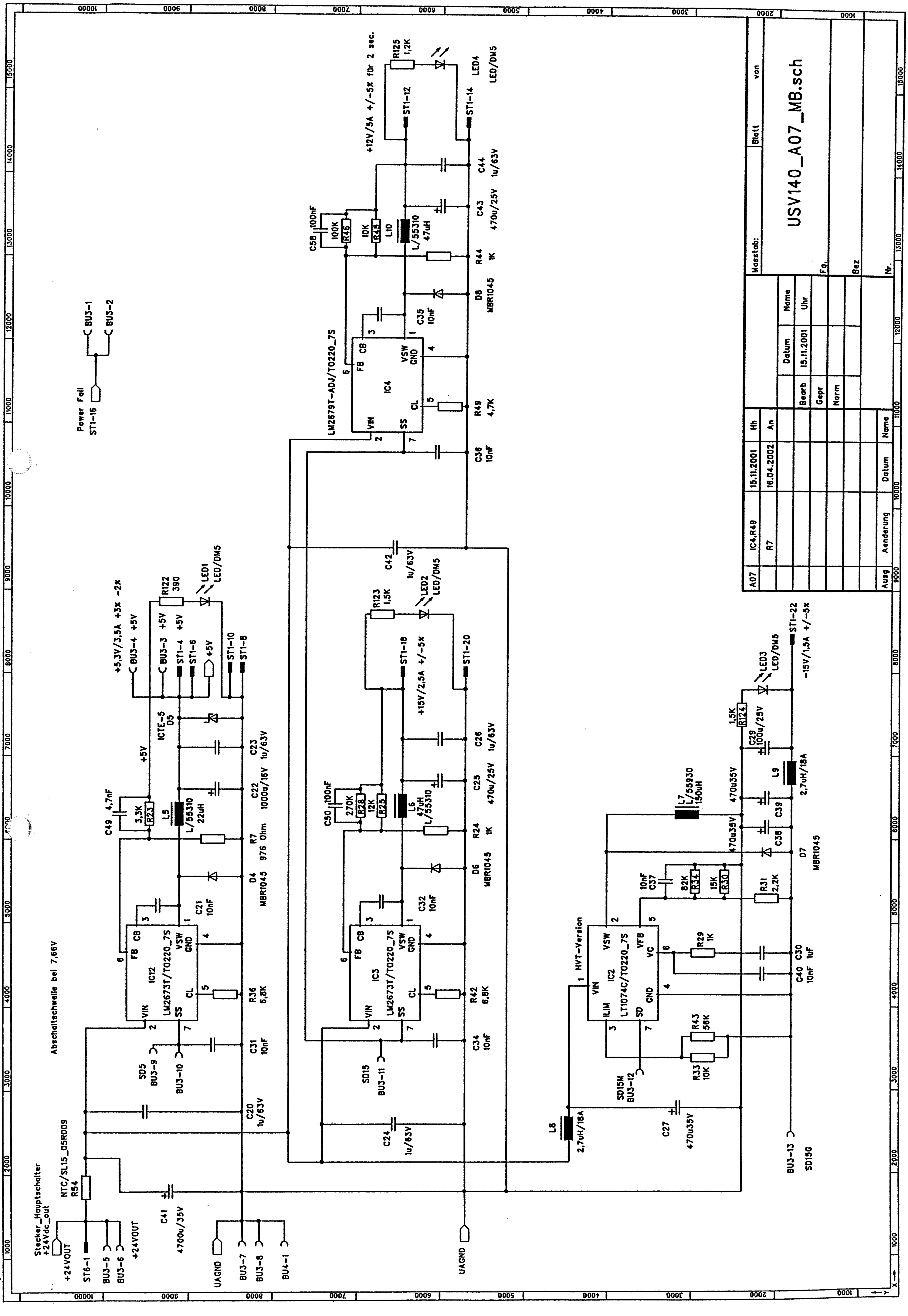
HAMILTON MEDICAL AG

SA 604.934 Rev. 03

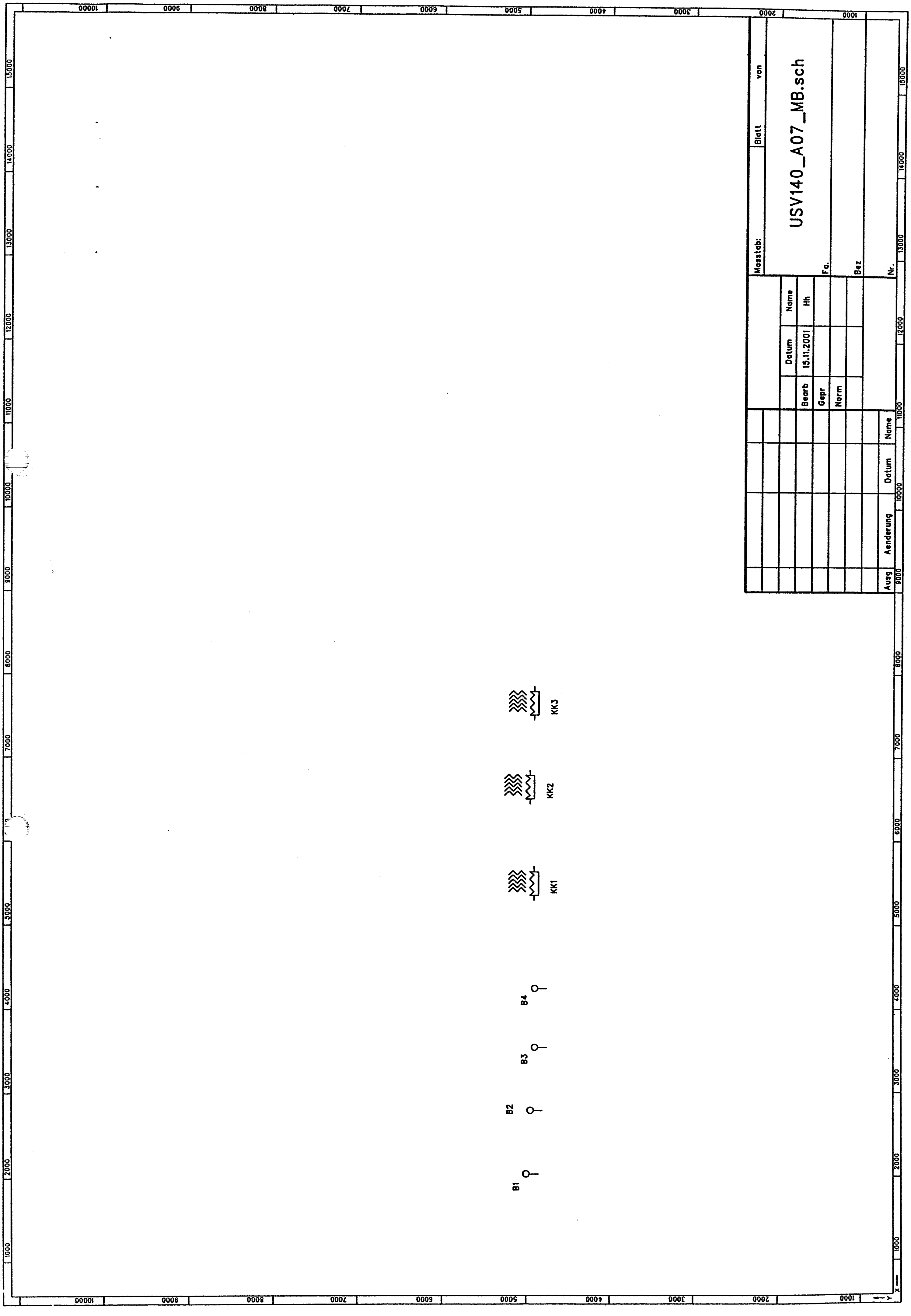
Design Path: $PROJECT_GAMMA_EL/boards/155.360 A5 interfaceboard


Dipl.Ing.Udo Huhn-Rohrbacher
Leistungselektronik
Wohnlichstrasse 6-8 D-75179 Pforzheim
USV140_A07_MB.sch
Masstab:
Blatt
von
Schaltplan USV140_A06_MB gehört zu Layout ADUSV 140_A04_MB
Schaltplan USV140_A07_MB gehört zu Layout ADUSV 140_A04_MB
Die Widerstände R102, R107 sind Abgleichwiderstände "Abgl"
Netzbetrieb = 5V=High
Power-LED I= 10 mA
TDA4605/DIP
alt.TDA4605-3
LT1074CT-7/TO220_7S
ER42_20SW_USV140
TR1
SPW20N60S5
BYW81PI-200
KBU6K
V275LA20
SFH617
CL431LP
Ausg Aenderung Datum Name
A02 update 01.07.99 Uhr
update 29.07.99 Uhr
update 07.09.99 Uhr
A04 F1-6,3AT 06.2000 An
A05 R54,J1auf24Vout 10.2000 An
A06 R1,R6,R102 09.2001 Uhr
A07 R11,R12,C5 15.11.2001 Uhr
A07 C54 15.11.2001 Uhr
Bearb 07.09.99 Uhr
Gepr 5.11.99 AN
Norm 26.09.2001 Hh
15.10.2001 Hh

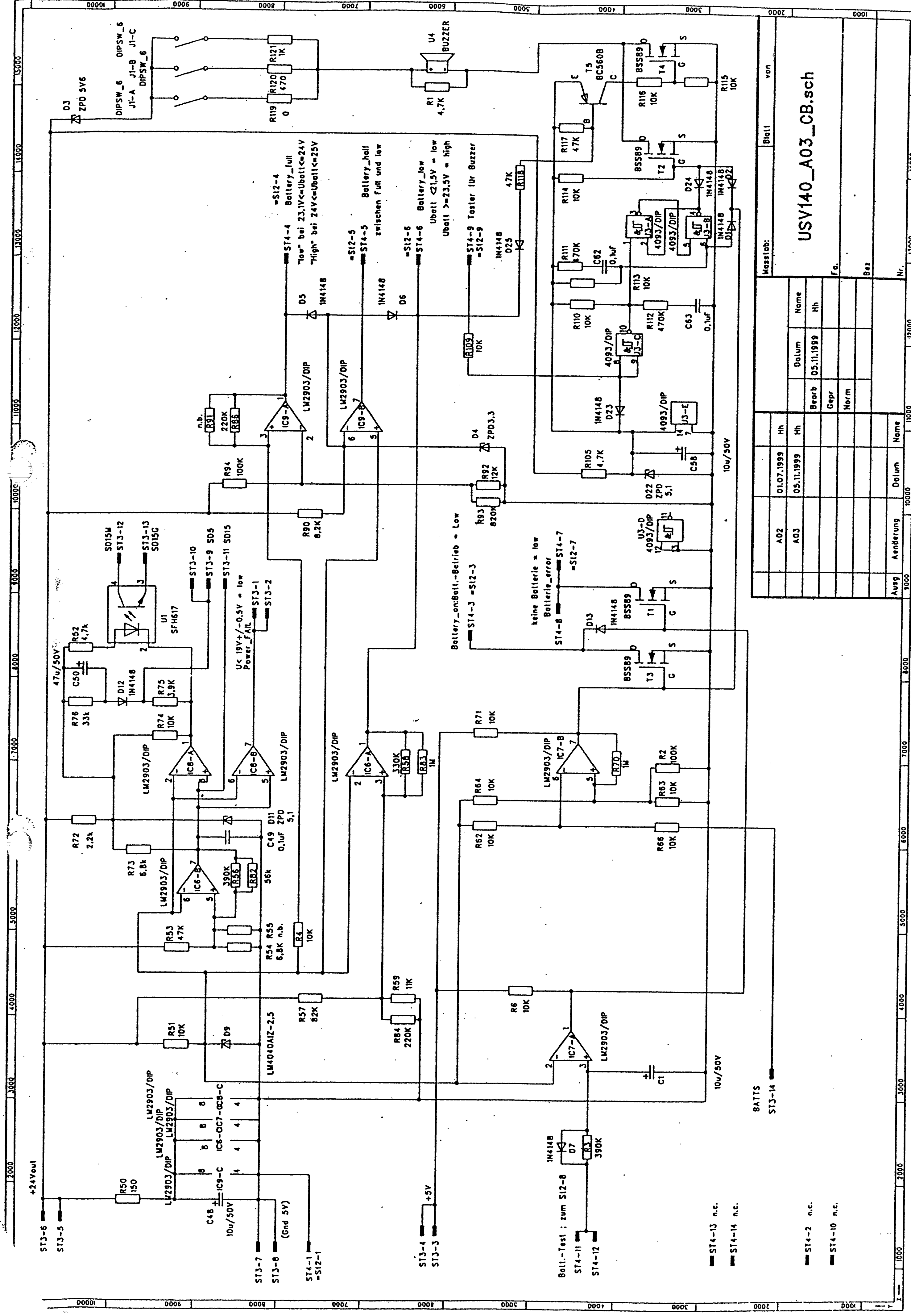
USV140_A07_MB.sch-2 - Mon May 06 14:05:51 2002



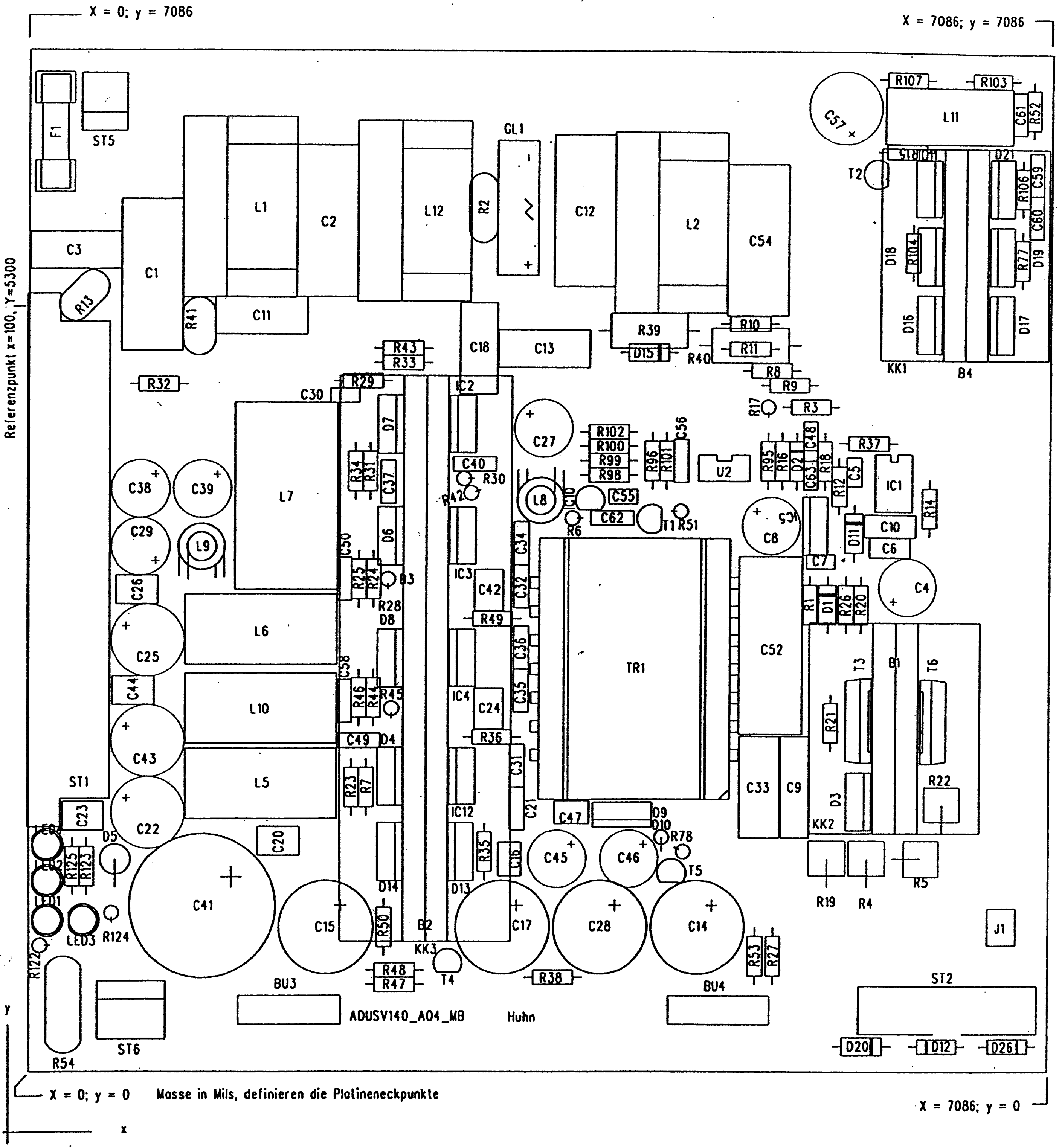
USV140_A07_MB.sch-3 - Mon May 06 14:05:52 2002



USV140_A03_CB.sch-1 - Sat Nov 06 09:56:15 1999



Copy



Platine 123.11.0134 UL-94V-0

USV140_A04_MB

thickness: 2mm ,70u copper;FR04_V0;throughplated

Layer1 = top side = component side

Dipl.Ing. Udo Huhn-Rohrbacher

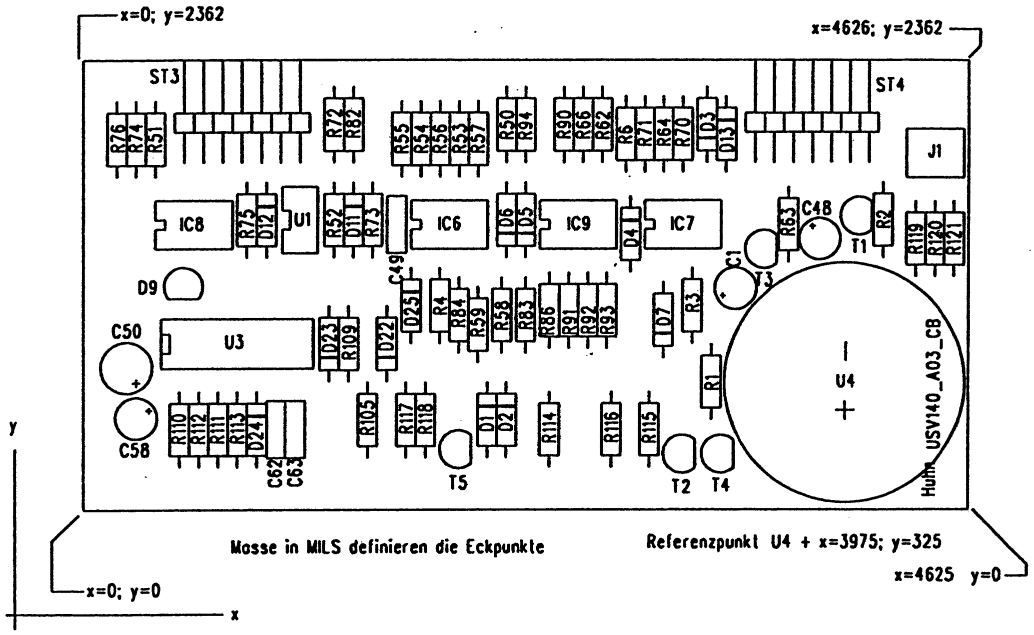
Wohnlichstrasse 6-8

D-75179 Pforzheim

phone: +497231/441262; Fax: +497231/441240

08.11.2000

gen01.pho - Thu Nov 09 10:56:58 2000



Platine 123.11.0135 USV140_A03_CB

thickness: 1,6mm; 70 copper; FR4_V0; throughplated

Layer 1 = top side = component side

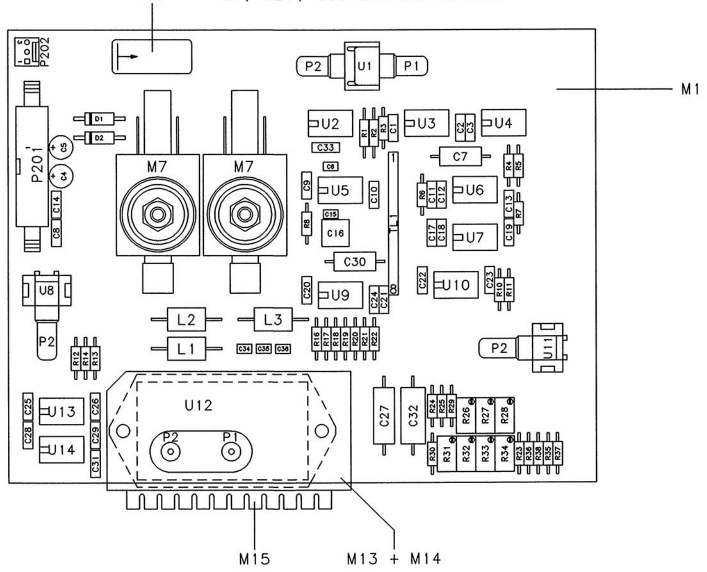
Dipl.Ing. Udo Huhn-Rohrbacher

Wohnlichstrasse 6-8

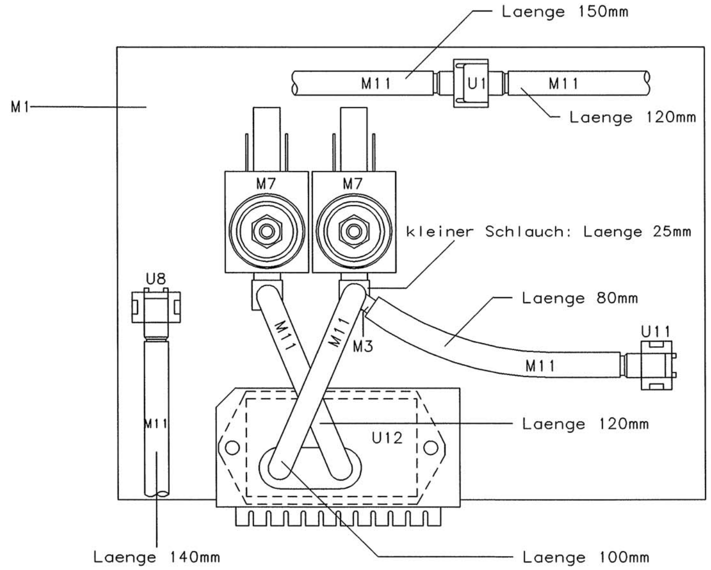
75179 Pforzheim; phone: +497231/441262; Fax: +497231/441240

05.11.1999

C7, C27, C30 und C32 sicken

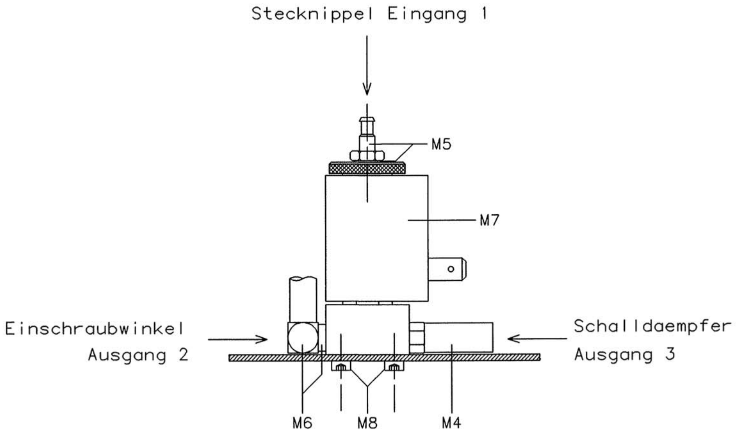


Verschlauchung kpl.

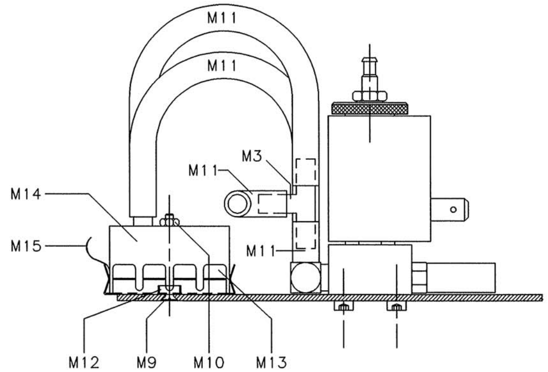


Schlauchtoleranzen: +-3mm

Montage AZ-Ventile



AZ-Verschlauchung



M10 mit 60 Ncm festziehen

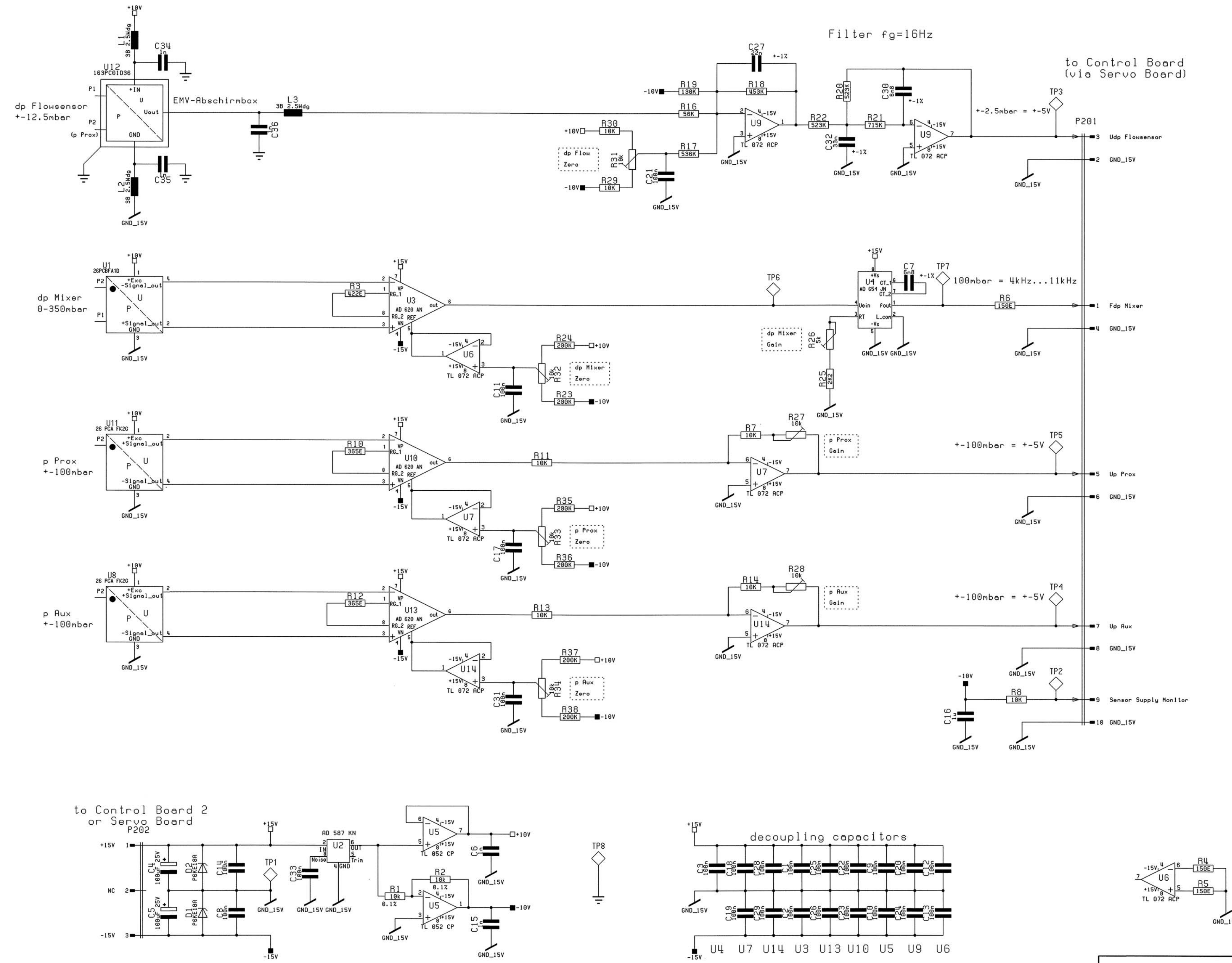
Sensor Board	Masstab 1 : 1 bei A2	BPL	155.153	Blatt	1
		SA	604.912	von	1
		Gez.	Martin Lutz	1996-09-05	
		Gepr.	[signature]	2003-06-24	
HAMILTON MEDICAL AG		BSP 155.152		Rev. 04	

Design Path: /user/gamma_el/boards/155_152_03_sensorboard
Plot Abs: Silvio Caminada 2003-06-24T12:54:48

CADel

Revision	01	02	03	04
Aend.-Nr.	7873	7896	8923	M124
Datum	97-03-17	97-04-02	00-04-11	03-06-05
Name	M. Lutz	M. Lutz	D.Proyer	Caminada

Aenderg.



Revision	01	02	03	04	05
Aend. Nr.	7873	7896	8029	M124	M124
Datum	97-03-17	97-05-20	97-09-09	03-05-27	03-12-11
Name	M. Lutz	M. Lutz	M. Lutz	Caminada	Caminada
Aenderg.					

Sensor Board

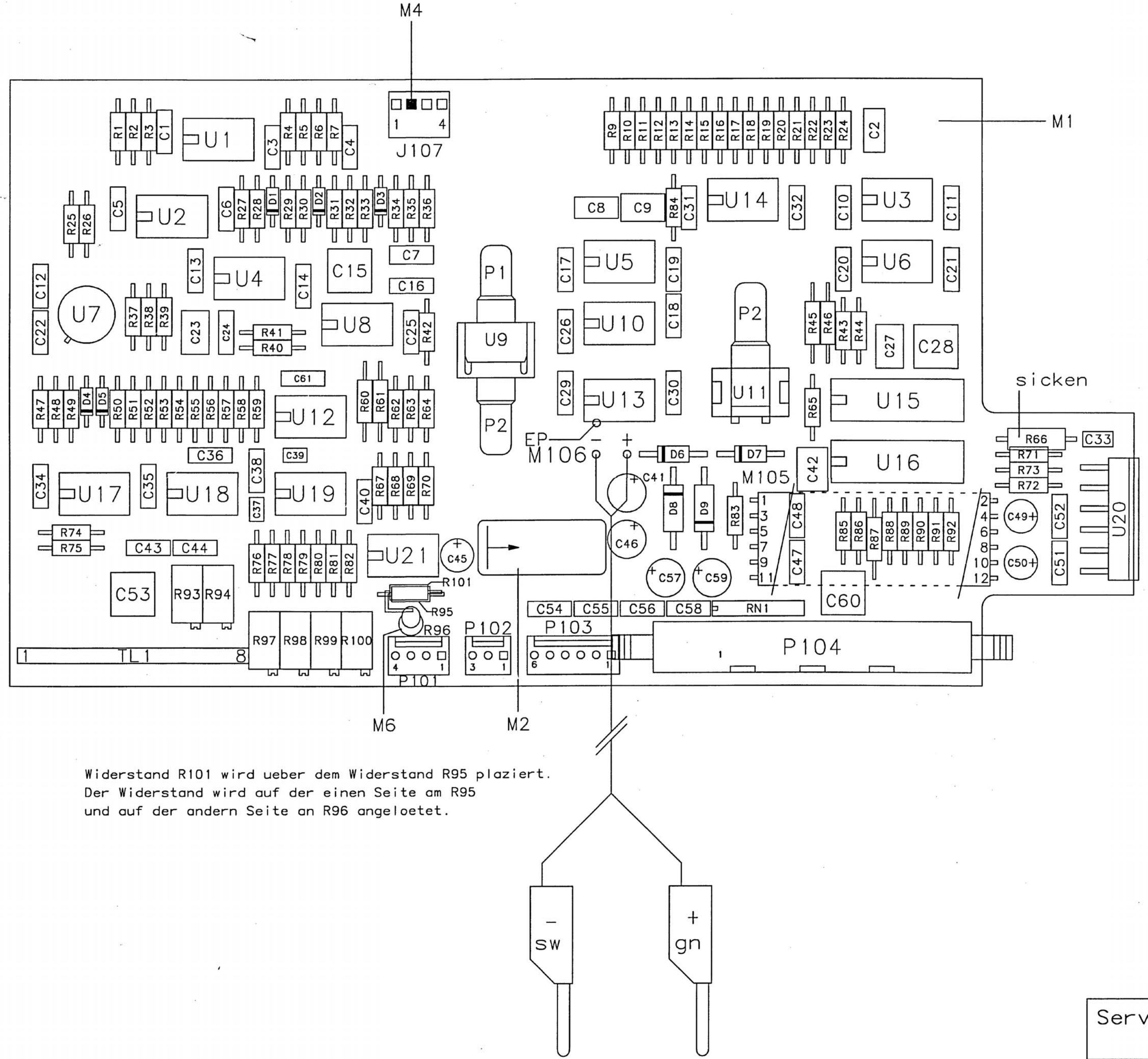
BSP	155.152	Format	Blatt 1
BPL	155.153	A1	von 1
BD			
WD			
Gez.	Martin Lutz		1997-05-20
Gepr.			

HAMILTON MEDICAL AG

SA 604.912 05

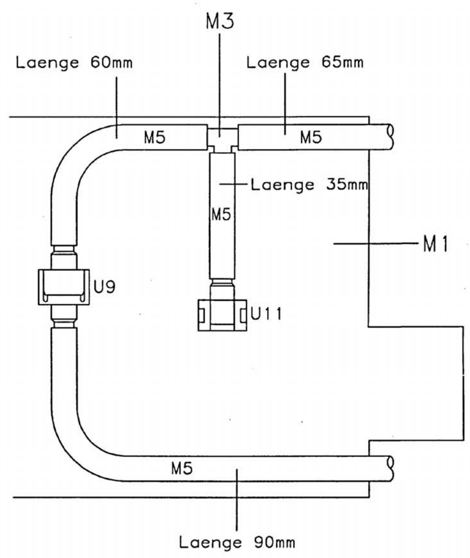
Design Path: $PROJECT_GAMMA_EL/boards/155_152_03_sensorboard_m124
Plot Abs.: Silvio Caminada 2003-12-15T09:56:04

CADel



Widerstand R101 wird ueber dem Widerstand R95 plaziert.
Der Widerstand wird auf der einen Seite am R95
und auf der andern Seite an R96 angeloetet.

Verschlauchung



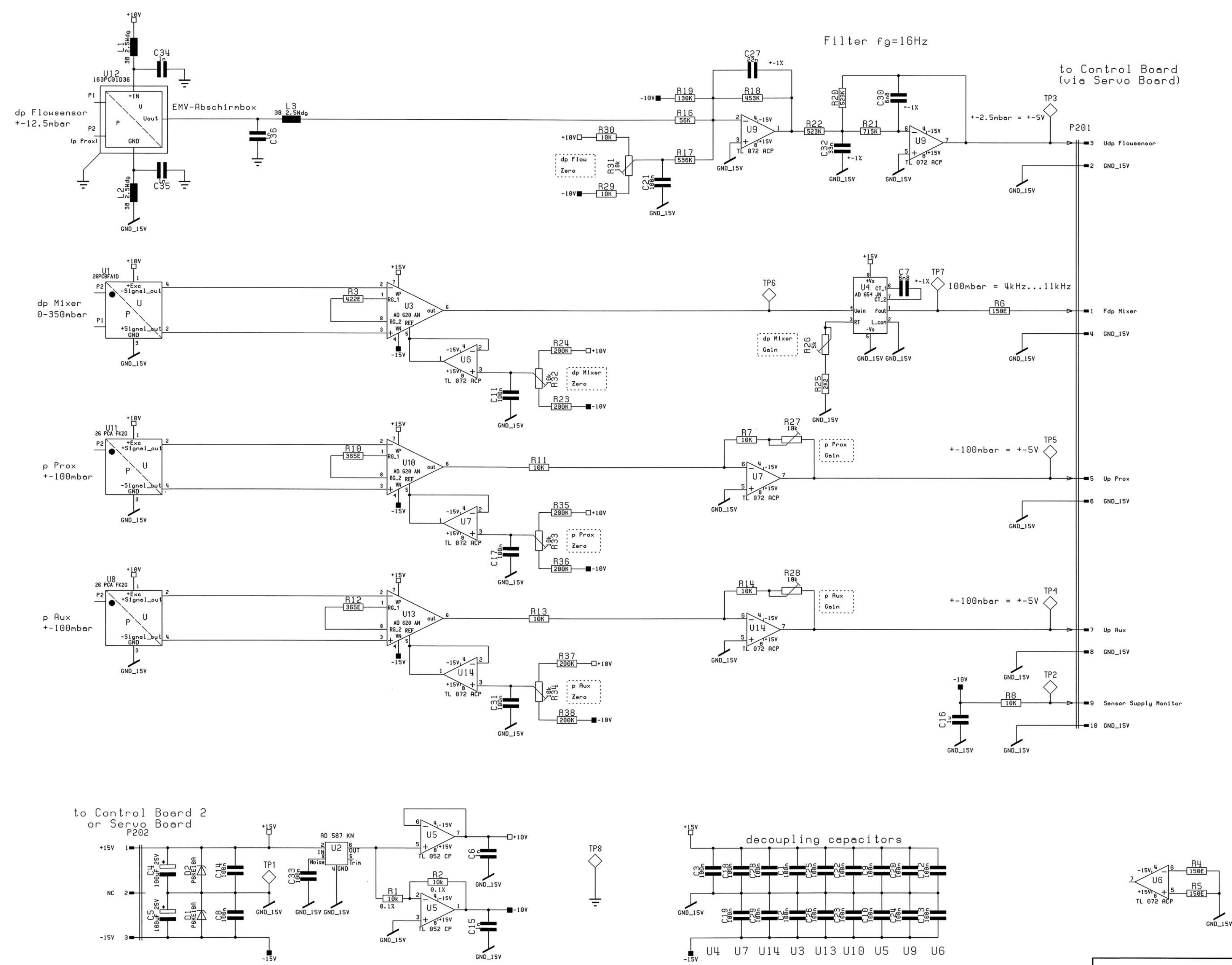
Schlauchtoleranzen: +-3mm

Aenderg.						
Revision	01	02	03	04	05
Aend.Nr.	7873	7896	7994	8361	8893
Datum	97-03-17	97-04-02	97-07-04	98-08-19	00-04-18
Name	M. Lutz	M. Lutz	M. Lutz	M. Lutz	D.Proyer

Servo Board	Massstab 2:1 bei A2	BPL	155.151	Blatt	1
		SA	604.910	von	1
		Gez.	Martin Lutz	1996-09-11	
		Gepr.	[signature]	2000-04-19	
HAMILTON MEDICAL AG		BSP 155.150		Rev. 05	

Design Path: /user/gamma_el/boards/155_150_07_servoboard
Plot Abs: Daniel Proyer 2000-04-18T16:44:15

CADel



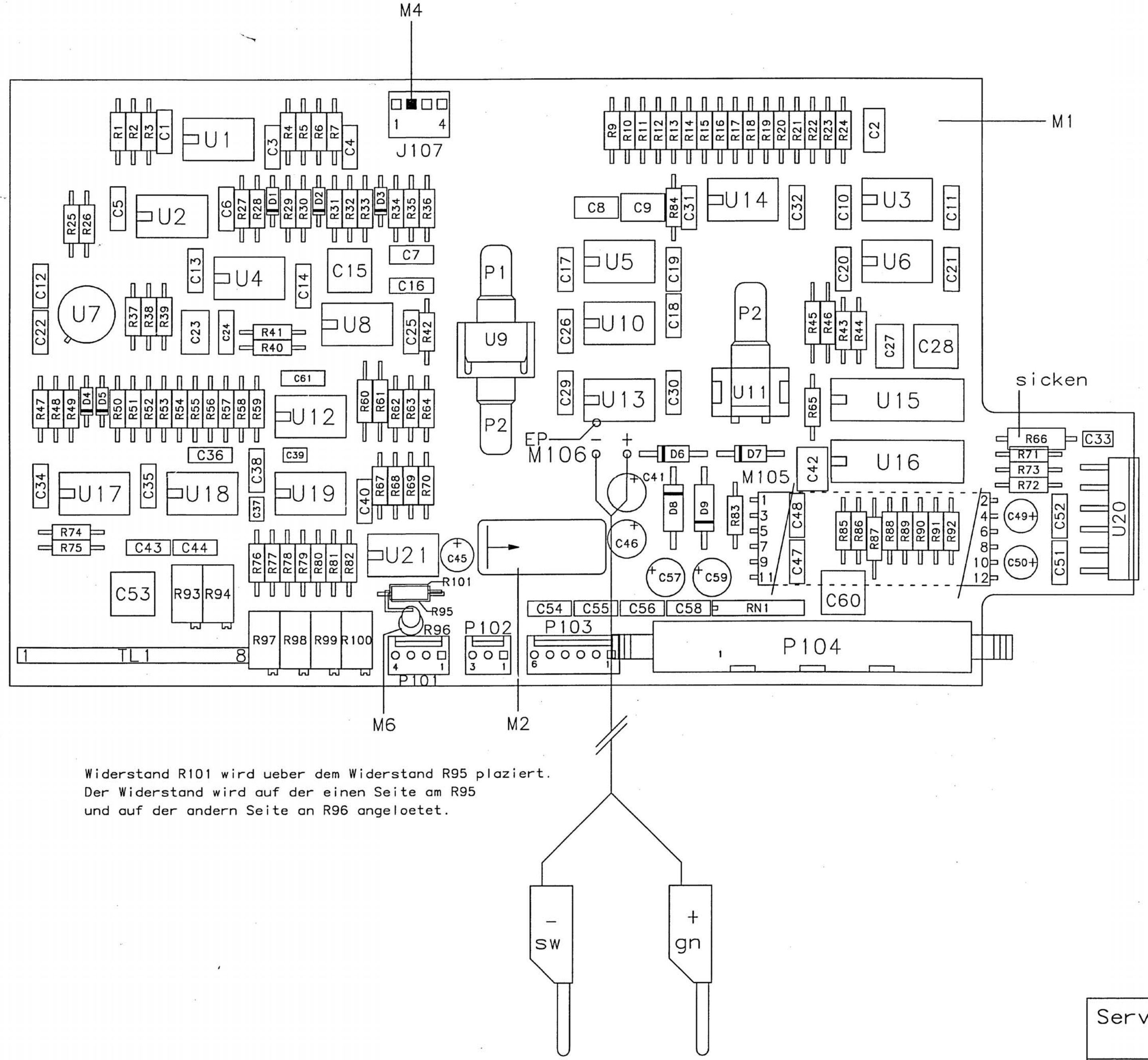
Revision	Aend. Nr.	Datum	Name
01	7873	97-03-17	M. Lutz
02	7896	97-05-20	M. Lutz
03	8029	97-09-09	M. Lutz
04	M124	03-05-27	Caminada
05	M124	03-12-11	Caminada

Aenderg.

Sensor Board	BSP 155.152 / BPL 155.153 / BD / WD	Format A1	Blatt 1 von 1
	Gez. Martin Lutz		1997-05-20
	Gepr.		2003-12-15
HAMILTON MEDICAL AG	SA 604.912		Rev. 05

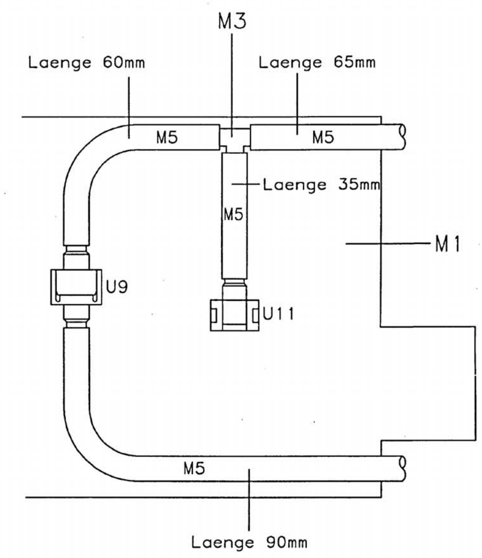
Design Path: $PROJECT_GAMMA_EL/boards/155_152_03_sensorboard_m124
Plot Abs.: Silvio Caminada 2003-12-15T09:5C:04

CADel



Widerstand R101 wird ueber dem Widerstand R95 plaziert.
Der Widerstand wird auf der einen Seite am R95
und auf der andern Seite an R96 angeloetet.

Verschlauchung



Schlauchtoleranzen: +-3mm

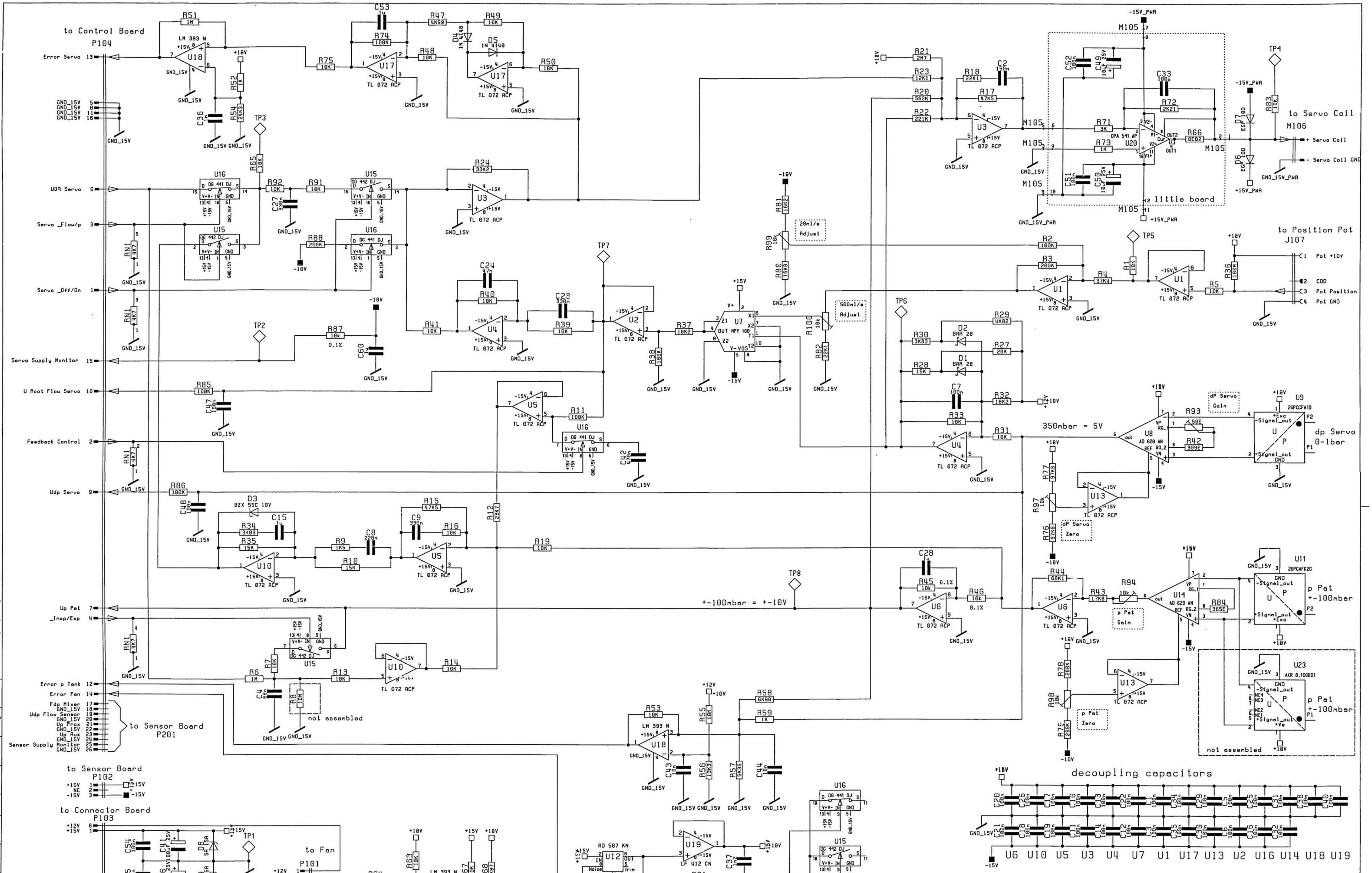
Revision	01	02	03	04	05
Aend.Nr.	7873	7896	7994	8361	8893
Datum	97-03-17	97-04-02	97-07-04	98-08-19	00-04-18
Name	M. Lutz	M. Lutz	M. Lutz	M. Lutz	D.Proyer

Aenderg.

Servo Board	Massstab 2:1 bei A2	BPL	155.151	Blatt	1
		SA	604.910	von	1
		Gez.	Martin Lutz		1996-09-11
		Gepr.			2000-04-19
HAMILTON MEDICAL AG		BSP 155.150		Rev.	05

Design Path: /user/gamma_el/boards/155_150_07_servoboard
Plot Abs: Daniel Proyer 2000-04-18T16:44:15

CADel



	Sensor Typ	R84	R78,R79	R43	R44
1nd Source	26PCAFK2G	365E	200k	17k8	68k1
2nd Source	AKR 0,100B01	750E	6k19	6k2	35k7

Servo Board

HAMILTON MEDICAL AG

SA 604.910 07

BSP 155.150 BPL 155.151 Format A1 Blatt 1 von 1

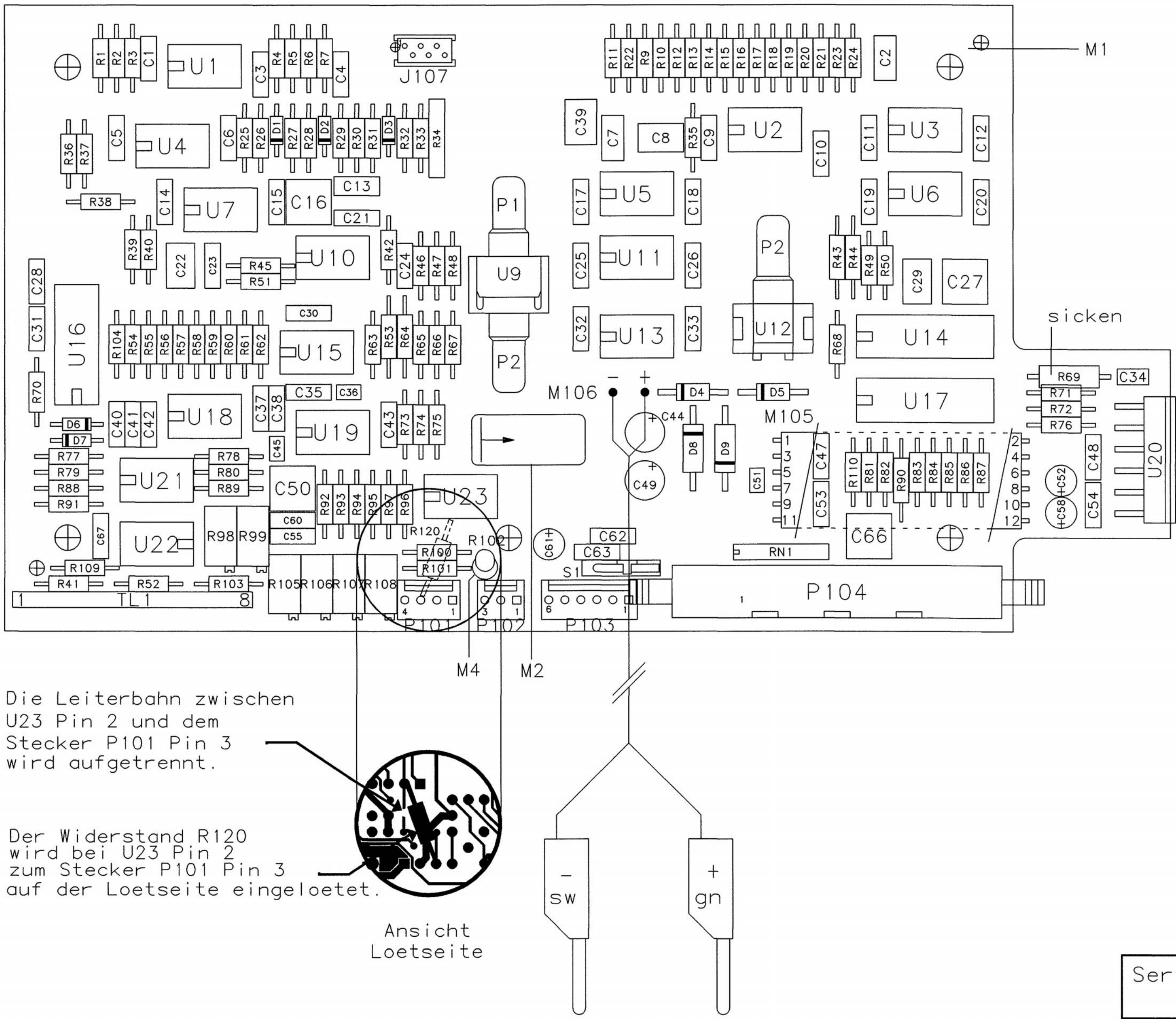
Gez. Martin Lutz 1996-09-11

Design Path: $PROJECT_GAMMA_EL/boards/155_150_07_servoboard
Plot Abs.: Daniel Proyer 2000-04-19T14:28:38

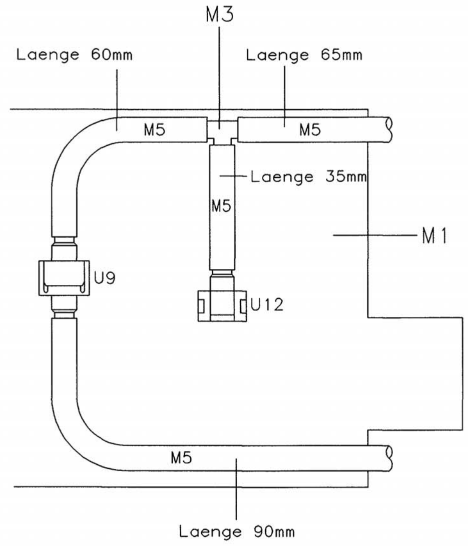
CADel

Revision	Aend. Nr.	Datum	Name
01	7873	97-03-17	M.Lutz
02	7873	97-04-02	M.Lutz
03	7896	97-05-07	M.Lutz
04	7994	97-07-04	M.Lutz
05	8029	97-09-09	M.Lutz
06	8361	98-08-19	M.Lutz
07	8893	00-04-18	D.Proyer

Aenderg.



Verschlauchung



Schlauchtoleranzen: +-3mm

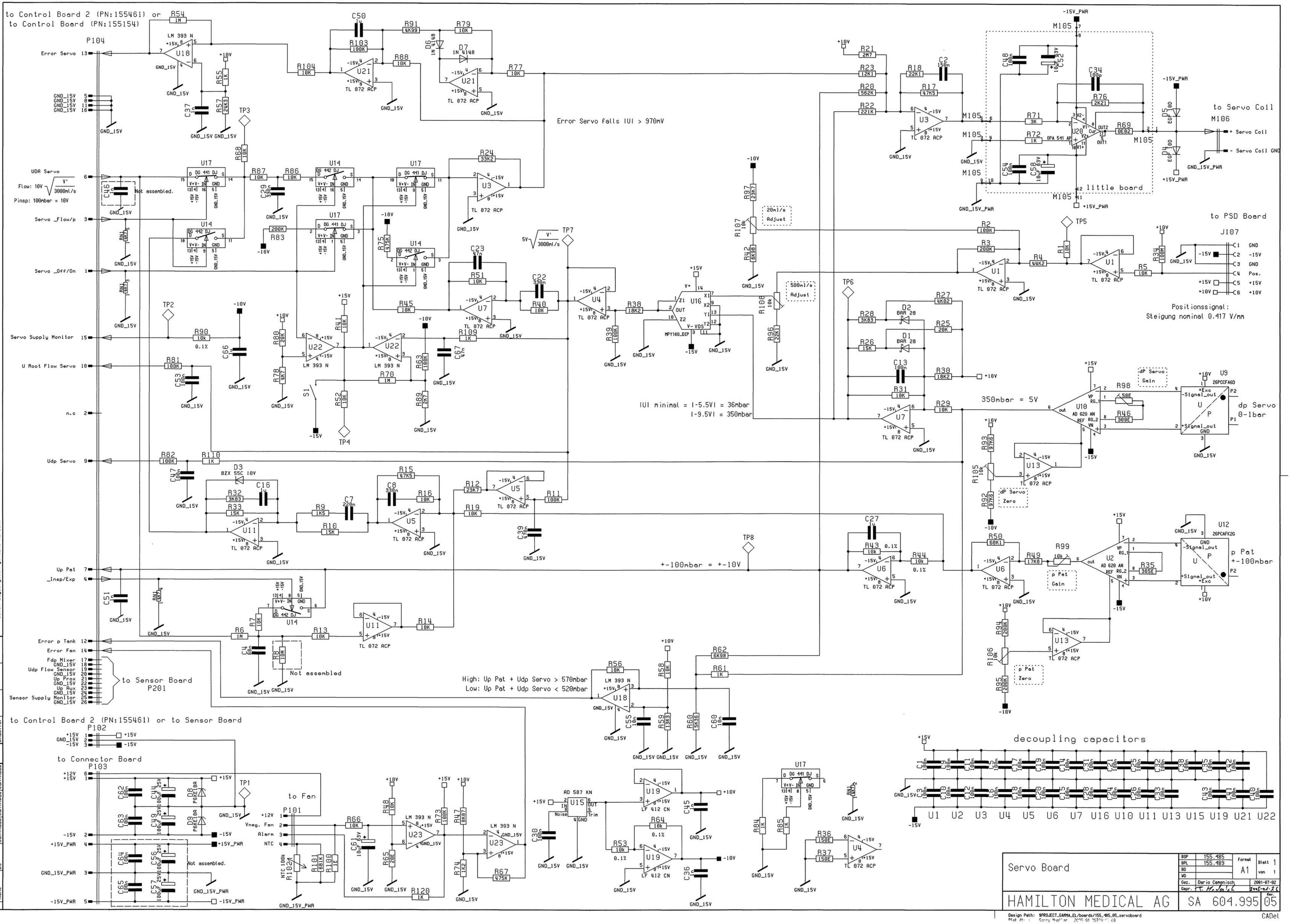
Revision	01	02	03
Aend.Nr.	M67	M188	M370
Datum	02-06-24	03-06-16	05-01-12
Name	DC	Caminada	Gmueller

Aenderg.

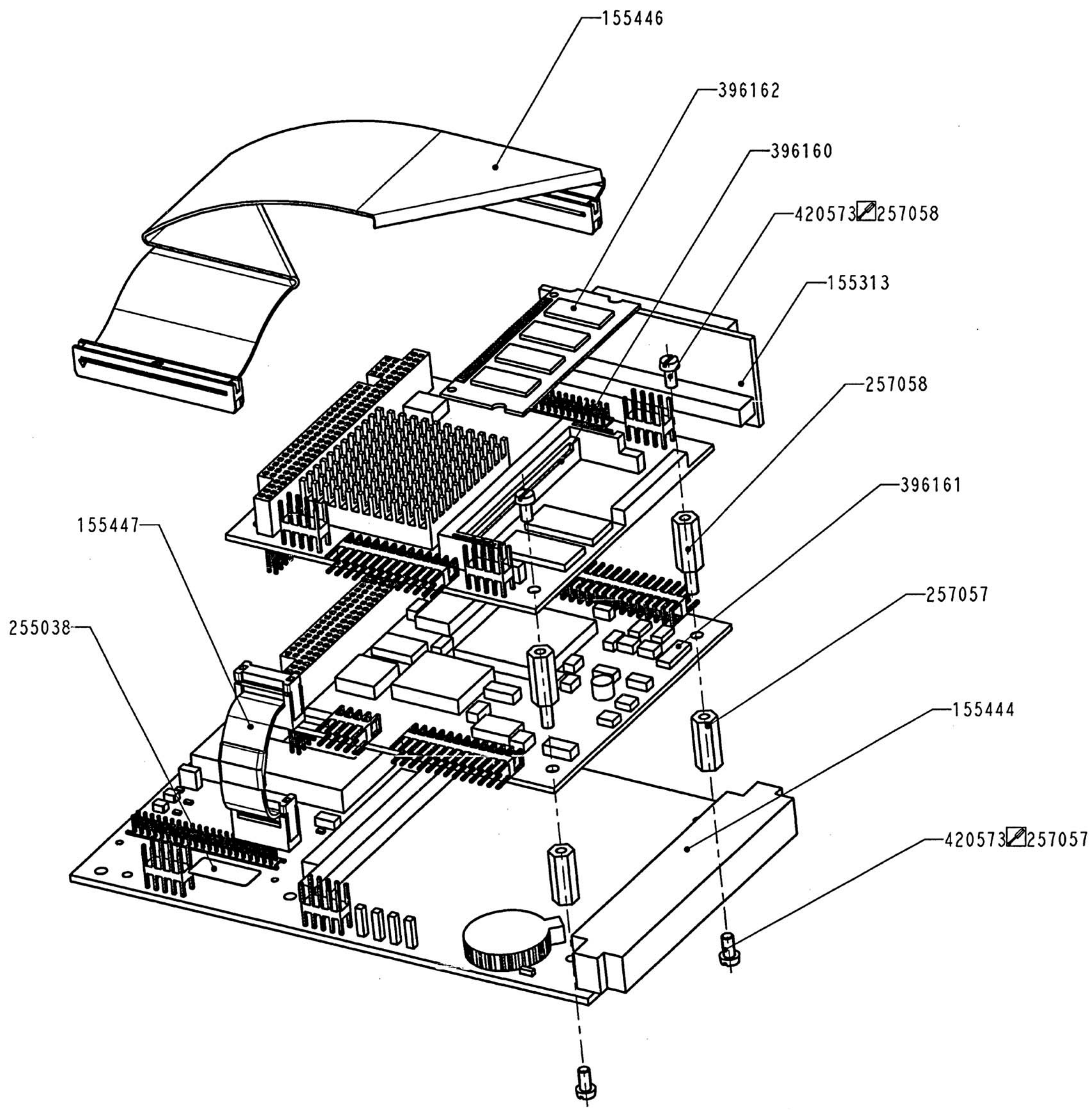
Servo Board	Masstab 2:1 bei A2	BPL	155.489	Blatt 1
		SA	604.995	von 1
		Gez.	D. Camenisch	2001-07-03
		Gepr.	F. H. [illegible]	2005-01-26
HAMILTON MEDICAL AG		BSP 155.485		Rev. 03

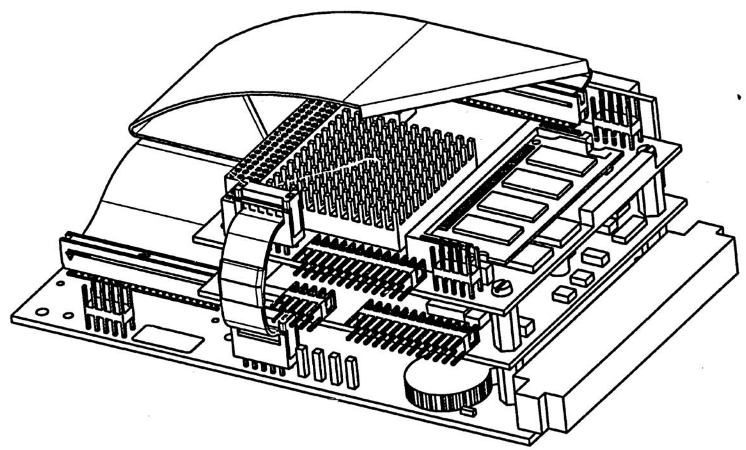
Design Path: /user/gamma_el/boards/155_485_05_servoboard
Plot Abs: Garry Mueller 2005-01-26T09:20:52

CADel



Diese Zeichnung gilt als den jeweiligen Inhaber persoenlich anvertraut. Das Eigentum und das Urheberrecht verbleibt der Firma. Ohne schriftliche Genehmigung darf sie weder kopiert noch Drittpersonen zugaenglich gemacht werden.



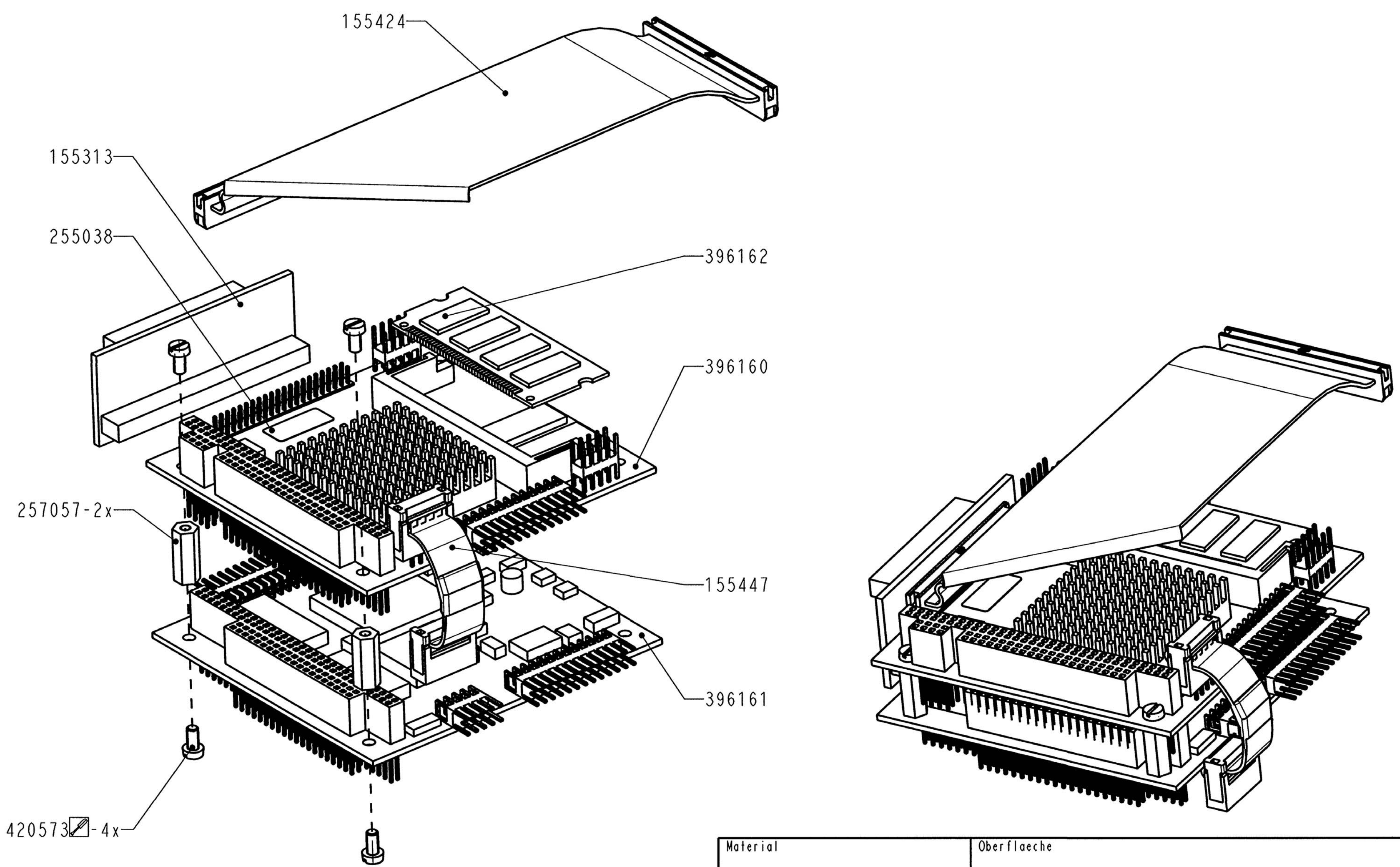


Diese Zeichnung gilt als dem jeweiligen Inhaber persoenlich anvertraut. Das Eigentum und das Urheberrecht verbleibt uns. Ohne unsere schriftliche Genehmigung duerfen die Zeichnungen weder kopiert noch Drittpersonen zugaenglich gemacht werden.

Modell Nr.	155460	Aend. Nr.	8893
Modell Rev.		Aend. Datum	2000-04-07
Objekttyp	ASSEM	Name	huder
Zeich. Rev.			

Material	Oberflaeche ∇(√)		
Single Bord Computer	Massstab 1/1 (A2)	Nicht tol. Masse ±	Blatt 1 von 1
		Gez. huder	2000-04-07
		Gepr.	2000-04-10
HAMILTON — Hamilton Bonaduz AG, P.O.Box 26, CH-7402 Bonaduz	ZCH155460		Rev. 00

Plot Abs.: Juerg Huder 2000-04-10T09:45



Modell Nr.	155499	Aend. Nr.	
Modell Rev.		Aend. Datum	
Objekttyp	ASSEM	Name	
Zeich. Rev.			

Material	Oberflaeche ▽(✓)			
Single Bord Computer 2	Massstab 1/1 (A3)	Nicht tol. Masse ±		Blatt 1 von 1
		Gez.	Ochem C	2001-11-29
		Gepr.	R. H.	2001-11-30
HAMILTON MEDICAL — Hamilton Medical AG, Via Nova, CH-7403 Rhäzüns	ZCH155499			Rev. 00

Plot Abs.: Christophe Ochem 2001-11-30T09:33

Appendix

J Glossary

This glossary offers definitions of expressions not included, or extended definitions of expressions briefly included, in the glossary of your GALILEO's operators' guide. It should be used together with the glossary in the guide.

alarm buffer	An area of memory containing details of the most recent twenty alarms. You can access the most recent six alarms of the twenty in the alarm buffer, by using the M-knob to activate the alarm symbol at the bottom left of the screen when GALILEO is in normal operating mode.
ambient state	A state that GALILEO uses when it cannot function normally because of an internal or external fault. In this state, the *inspiratory (servo) valve* closes, the *expiratory valve* opens, and the *mixer valves* shut off the air and oxygen supply to the tank. The patient is not actively ventilated in any way, but is allowed to inhale through the *ambient valve* if he or she is able to do so. The ambient state is often associated with a *technical faults*, but can also be caused by such things as a failed air or oxygen supply. It is always accompanied by the high-priority patient alarm, sounded by the loudspeaker or *buzzer*.
ambient valve	A valve that, when ***not*** activated, enables air in the room to enter the patient breathing circuit. The valve is held closed by a solenoid during normal ventilation, but can open in response to a patient's efforts to inhale, when GALILEO is in *ambient state*. The ambient valve is part of the safety valve block.
ambient valve solenoid	The solenoid that holds the *ambient valve* closed during normal ventilation.
autorinse	See *rinse flow*.
autorinse assembly	In reality, this is not an assembly, but comprises three outlets from the tank, each partly occluded by a sintered-plate flow-restrictor. The expression is not used in this manual. See also *rinse flow* and *Paux*.
autozero valves	See *Flow Sensor autozero valves*.
BIOS	The Basic Input Output System for the central processing unit (CPU). This is held on an EPROM or EEPROM mounted on the *GMP* assembly.
buzzer	A piezoelectric device mounted on the *connector board*, used by GALILEO to sound some alarms. It functions independently of the loudspeaker and the main power supply, and typically indicates a high-priority technical fault that causes GALILEO to go into the ambient state. **Note** Despite its name, the buzzer makes a high frequency sound.
communication interface	The RS232 port and the Special (analog) port on the rear of the GALILEO. The RS232 port is used to communicate with peripherals such as a computer or monitor, and the Special port is used to activate the external nurse alarm.
CompactFlash	A trademarked expression for a solid state memory medium. In GALILEO there can be two on the Upgrade 2 *control board*. One contains the GMP software. The other (which is optional) can be used to download the *event log*. See also *GMP software CompactFlash*.

connector board	A printed circuit board that manages: • Other circuit boards • Valves • Keys on the front of the GALILEO • Power supply • P&T-knobs It is positioned below the *control board* and directly above the Flow Sensor and nebulizer connectors.
control board	The printed circuit board on which are mounted the integrated circuits containing most of the control logic. These are: • *GCP* • *GMP* • *GPT* The control board manages inputs and outputs from most parts of GALILEO including the user interface. It also performs A/D and D/A conversion. It is positioned directly behind the LCD display.
dc/ac board	A printed circuit board positioned under the *control board* that converts the 12 V dc power supply to 1500 V ac for use by the LCD lights.
dP Flow Sensor	Flow Sensor differential pressure. A measurement of the pressure difference between the front and rear chambers of the *Flow Sensor*. The measurement is performed by a pressure sensor inside the GALILEO, and is used to calculate airway gas flow. See also: • *Flow Sensor* • *Flow Sensor differential-pressure sensor*
dP Flow Sensor differential pressure sensor	The pressure sensor that measures the *dP Flow Sensor* value. It is positioned on the *sensor board*.
dP mixer	Mixer differential pressure. A measurement of the pressure difference across a restrictor placed in the outlet of the gas *mixer*. The flow of gas from the mixer to the tank is calculated from this value.
dP mixer differential pressure sensor	The pressure sensor that measures the *dP mixer* value. It is positioned on the *sensor board*.
dP servo	Servo differential pressure. A measurement of the pressure difference between the inflow and outflow of the inspiratory (servo) valve. The flow of gas to the patient is calculated from this value and from the position of the plunger in the valve.
dP servo differential pressure sensor	The pressure sensor that measures the *dP servo* value. It is positioned on the *servo board*.
expiratory valve	A valve controlling pressure in the patient circuit, thereby enabling the patient to exhale, and enabling the GALILEO to maintain PEEP. It comprises positioning coil, membrane and cover. Its function is synchronized with that of the *inspiratory (servo) valve*.
external interface	See *communication interface*.
external nurse alarm	See *communication interface*.

event log

A record of most activity in the GALILEO. This includes user actions and internal activity such as:

- Calibration results
- Alarms
- Technical faults
- Controls settings
- Configuration, serial numbers, revision numbers
- Switch-on times

The event log always holds a minimum of 4,000 events. Switching off and on the GALILEO does not delete memory.

You can access a subset of the event log suited for clinical use by activating the Event Log symbol in the monitoring menu in normal operating mode.

Other subsets of the log, or the full contents of the log, are available in *test mode* if you are running Upgrade 2 software. This is fully explained in Unit 17.4, *Viewing the event log*, on page 10-99.

Flow Sensor

(proximal Flow Sensor)

A device in the patient breathing circuit, proximal (very close) to the patient, that measures gas flow to and from the patient airway, and pressure proximal to the patient airway. Flow is measured indirectly, being calculated from the pressure difference between the front and rear chambers of the sensor.

See also:

- *dP Flow Sensor* (the measured value)
- *Flow Sensor differential-pressure sensor* (the pressure-sensing device)

Flow Sensor autozero valves

Two valves, each controlling one side of the Flow Sensor circuit. During normal use they open at calculated intervals to bring both sides of the Flow Sensor differential-pressure sensor to ambient pressure. This enables GALILEO to perform a zero calibration of the pressure sensor (used to measure the differential pressure in the Flow Sensor — the *dP Flow Sensor* reading). This calibration is necessary to offset the drift in sensor values that takes place with temperature change.

The Flow Sensor autozero valves are positioned on the *sensor board*.

Flow Sensor differential-pressure sensor

A pressure sensor inside GALILEO that measures the pressure difference between the front and rear chambers of the *Flow Sensor*.

See also, *dP Flow Sensor* (the value measured by the sensor).

GCP

GALILEO Control Processor. A microprocessor that calculates values to control the valves that, in turn, control the pneumatic circuits. The GCP software is contained in the external *GCP PROM*.

The GCP is positioned on the *control board*.

GCP PROM

The PROM that contains the software for the *GCP*.

Like the GCP, it is positioned on the *control board*.

GIP

GALILEO Interface Processor. A microprocessor that manages the *communication interface*.

It is positioned on the *interface board*. (The interface board is only present when the communication interface option is fitted to GALILEO.)

GIP EPROM

The EPROM that holds the software for the *GIP*.

Like the GIP, it is positioned on the *interface board*.

GMP

GALILEO Main Processor. An assembly containing the microprocessor that controls both the user interface and high-level aspects of ventilation, such as tidal volume, minute volume and rate.

The software for the GMP resides on the *GMP software CompactFlash*

The GMP assembly includes the *VGA graphics card*.

GMP software CompactFlash

A removable *CompactFlash* memory card that contains the software that runs the *GMP*.

In original and Upgrade 1 GALILEOs, the CompactFlash memory (containing the GMP software) and the GMP processor were part of the same assembly. In Upgrade 2 GALILEOs (SN 4000 and higher), the CompactFlash card is mounted on the *control board*.

GPT

GALILEO Press-&-Turn controller. A microcontroller with on-chip ROM and RAM that manages the control and the monitoring press-&-turn knobs, and the four keys on the front panel.

The GPT is mounted on the control board.

indicator board

A printed circuit board containing LEDs that display the status of the 12 V batteries in the column and the 230 V mains power supply.

The board is in the column.

Note

The schematic dealing with the indicator board is labelled “Ueberwachungs board”.

interface board

An optional printed circuit board, that supports the *communication interface*.

inspiratory (servo) valve

A valve controlling the pressure or flow (depending on mode) of the air/oxygen mixture to the patient breathing circuit. Its function is synchronized with that of the *expiratory valve*, and it is controlled by the *GCP*.

Also called the servo valve.

mixer

A device for mixing air and oxygen from the air and oxygen inlets.

In structure, it is a vessel with air and oxygen inputs, each controlled by a valve that in turn is controlled by the *GCP* in response to the user’s FiO_2 setting.

mixer differential-pressure sensor

See *dP mixer differential pressure sensor*.

mixer valves

The two solenoid valves regulating the flow of air and oxygen into the mixer. The operation of these valves determines the gas mixture and gas pressure in the tank.

See also *dP mixer*.

nebulizer compressor

A reciprocating pump that compresses gas for an external nebulizer. Because the gas is supplied to the pump by the tank, the gas mixture delivered to the nebulizer is identical to the gas mixture delivered at the to-patient port.

The nebulizer is an option on GALILEO. When included, it is positioned behind the fan and above the *inspiratory (servo) valve*.

nebulizer compressor membrane

A rubber membrane that completely isolates the gas flow through the upper part of the nebulizer compressor from the reciprocating connector rod. The membrane takes the place of what would otherwise be a piston.

oxygen cell

A small, replaceable, plastic unit used by GALILEO to measure oxygen concentration. (Also known as O2 cells.)

Oxygen cells react to the presence of oxygen, producing a voltage in proportion to the oxygen concentration.

A cell must be replaced by the user after a period of service, after which GALILEO can no longer calibrate it. Typically, this service life is about a year.

oxygen cell valves

Two solenoid valves that by functioning together control the flow of:

- air from the air inlet
- oxygen from the oxygen inlet
- the gas mixture in the tank

to the *oxygen cell*.

The valves enable GALILEO to calibrate the oxygen cell using oxygen and air, and to monitor the gas mixture in the tank.

patient alarm

An alarm indicating that there is a problem or potential problem in ventilating the patient.

There are three levels of patient alarm: high, medium and low. They are indicated by tones on the loudspeaker and messages on the LCD display.

patient overpressure valve	An internal non-electronic valve that opens the patient breathing circuit to the external atmosphere in the event of overpressure (caused, for instance, by the GALILEO malfunctioning, or a patient coughing).
Paw	Patient airway pressure. A measurement of the pressure in the patient breathing circuit as measured at the Flow Sensor, in the chamber attached to the blue (patient side) pressure-sensing tube. Paw is sometimes referred to as the Pprox (proximal) pressure. See also *Ppat*.
Paw pressure sensor	The pressure sensor that measures the *Paw* value. It is positioned on the *sensor board*.
Paux	Auxiliary pressure. A measurement of the pressure at a point determined by the user. For example, this could be pressure in the carina or esophagus. **Note** The Paux connector is supplied with a *rinse flow*. You must disconnect this to measure pressure in the esophagus.
Paux pressure sensor	The pressure sensor that measures the *Paux* value. It is positioned on the *sensor board*.
power supply	The power supply in the column of the GALILEO comprises the following parts: • Voltage regulator • Two 12 V batteries (not present in some early models) • Battery charger (not present in some early models)
Ppat	Patient pressure. A measurement of pressure at the inspiratory valve outlet. See also *Paw*.
Ppat pressure sensor	The pressure sensor that measures the *Ppat* value. It is positioned on the *servo board*.
principle gas flow	The main gas flow through GALILEO from the gas inlets to the patient, and then from the patient through the expiratory valve. (In other words, ***not*** the minor gas flows, such as the one to the oxygen cell.)
PSD board	Photo sensitive device board. A small printed circuit board mounted directly on the *inspiratory (servo) valve*. You cannot service or exchange this board alone, you must replace the inspiratory valve module.
rinse flow	A very small, continuous flow of gas from the tank through both the blue (patient side) and clear (ventilator side) Flow Sensor tubes to the Flow Sensor. The flow minimizes the possibility of tube blockage, and hinders the potential migration of bacteria and viruses from the patient's expired gases through the tubes, towards the pressure sensors inside the ventilator. The auxiliary pressure (Paux) connector is also supplied with a rinse flow, which can be cancelled when making esophageal measurements. For more information, see Section 11.32.6.2, *Cancelling the auxiliary-pressure rinse-flow*, on page 11-205.
safety valve block	A unit within GALILEO comprising the *ambient valve* and the *patient overpressure valve*.
sensor board	A printed circuit board positioned at the back of the GALILEO onto which the pressure sensors are mounted that measure the following values: • *dP Flow Sensor* • *dP mixer* • *Paw* • *Paux*
servo board	A printed circuit board positioned to the side of the *inspiratory (servo) valve*. It controls the inspiratory valve. The *dP servo differential pressure sensor* is mounted on this board.
servo valve	See *inspiratory (servo) valve*.

single board computer	See *GMP*.
tank	The metal vessel holding the air/oxygen combination delivered by the mixer. The relatively large volume of the tank (6 liters) enables GALILEO to deliver high peak flows when required, and to deliver a steady flow of air to the patient at all times.
tank overpressure valve	A passive, mechanical valve that is opened by the pressure of the gas in the tank, if that pressure becomes sufficiently high.
technical events	A very minor fault or event recorded by GALILEO in the *event log* for use only by software developers. Technical events are numbered from TF 80 to TF 2999. For more information, see Section 12.2.1, *Technical faults compared to alarms and technical events*, on page 12-2.
technical faults	An alarm condition indicating a major malfunction of GALILEO. (This contrasts with an alarm, that indicates a problem with the status of a patient.) Technical faults are intended to alert users and engineers of the need for intervention, and are recorded in the *event log*. Technical faults are numbered from TF 5500 to TF 9999. For more information, see Section 12.2.1, *Technical faults compared to alarms and technical events*, on page 12-2.
test mode	A special mode in GALILEO in which 16 units enable you to perform a range of checks and calibrations. (GALILEOs with Upgrade 2 software also have an additional unit that enables you to view and export data from the *event log*.) You access test mode by pressing and holding the **100% O_2** and **MANUAL** keys, and then switching on the mains power. **WARNING** **When it is in test mode, the GALILEO cannot be used for patient ventilation.**
VGA graphics card	A printed circuit board used to control the LCD display with most GMPs. Where fitted, it is a part of the *GMP* assembly. (The most recent GMP assembly, PN 396170, uses LCD adaptor PN 155563, which is not a true graphics card.)
Ueberwachungs board	This expression is used in two senses: • In the first sense, it is an alternative expression for the *indicator board*. You can find it in the title of the schematics detailing the indicator board. • In the second sense, it is the name of a small board on the *power supply*. (However, in the event of a power supply failure, you must exchange the complete assembly, and never only the ueberwachungs board. For this reason, it is not documented in this manual.)
watchdog	A part of the alarm system that reacts when an application process dies or does not respond to events or requests. Creates *technical faults* 99*xx*.

Index

Symbols

Numerics

A

B

C

D

E

F

U

V

W

GALILEO Original and Upgrade 1 Test Report

Name: ....
Date (YYYY/MM/DD): _ _ _ _/_ _/_ _
GALILEO serial number: _ _ _ _
Service Manual version: 610207/ _ _

Instructions:
1. Enter information on dotted lines.
2. Check (tick) check boxes if function correct.

General Maintenance

	Yes	No
3 V real-time clock battery replaced	❑	❑
Oxygen cell replaced	❑	❑
Fan filter cleaned or replaced	❑	❑
Gas inlet filters replaced	❑	❑
Nebulizer overhauled (using kit)	❑	❑
LCD display backlight replaced	❑	❑
Backup batteries in column replaced	❑	❑

TSW 1: GMP Selftest

GMP Ver: . . . .
GCP Ver: . . . .
GPT Ver: . . . .
GIP Ver: . . . .
BIOS Ver: . . . .
Date: . . . .
OS Ver: . . . .

Code Checksum: Displays **OK** OK ❑

Operating Hours: . . . .

TSW 2: GPT-GMP Communication

Selftest Status: Displays **4** OK ❑
Comm Testbyte: Increments OK ❑

GPT Testbyte: Displays **Done** OK ❑
GPT IRQ: Displays **Done** OK ❑

LED on:off OK ❑
LED flashing OK ❑
LED Intensity OK ❑
Emergency OK ❑
Relais on:off OK ❑

TSW 3: Display

All colors function OK ❑
Max. 4 grouped bad pixels OK ❑
Backlight switches on/off OK ❑

VGA-Contr.: ....
VGA-BIOS: ....

TSW 4: User Interface

Alarm High OK ❑
Alarm Medium OK ❑
M - Knob OK ❑ **C - Knob** OK ❑ **Alarm Low** OK ❑

Alarm OK ❑ **100% O2** OK ❑ **MANUAL** OK ❑ **NEBULIZER** OK ❑

TSW 5: GCP-GMP Communication

DPRAM Test Displays **OK** OK ❑ **Selftest Status** Displays **0** OK ❑
GPC Comm Test Displays **OK** OK ❑
GMP Comm Test Displays **OK** OK ❑
Busy Test Displays **OK** OK ❑

Collisions Value in range OK ❑
Collisions Value in range OK ❑
Testbyte GMP Increments OK ❑

TSW 6: A/D Conversion

ADC 12	Displays **4850** to **5250**	OK ❑
ADC 14	Displays **-990** to **-1010**	OK ❑
ADC 15	Displays **990** to **1010**	OK ❑
ADC 16	Displays **-10** to **10**	OK ❑

TSW 7: D/A Conversion

ADC 9	All values in range	OK ❑
ADC 10	All values in range	OK ❑

TSW 8: Zero and Fullscale

Ppat	Zero calibration OK ❑	Full-scale calibration OK ❑
Paw	Zero calibration OK ❑	Full-scale calibration OK ❑
Paux	Zero calibration OK ❑	Full-scale calibration OK ❑
dP Servo	Zero calibration OK ❑	Full-scale calibration OK ❑
dp mixer	Zero calibration OK ❑	
dP Flow Sensor	Zero calibration OK ❑	Full-scale check OK ❑

TSW 9: O2 Measurement

O2 Cal	Calibration	OK ❑
O2 Tank	All fields in range	OK ❑
Air	All fields in range	OK ❑
Oxygen	All fields in range	OK ❑

TSW 10: Mixer

Ptank	**300** to **280** mbar leak >8 s	OK ❑	Overpressure check <**500**	OK ❑
Ptank max	Displays **330** to **350**	OK ❑		
Flow_90ms	Displays **0 0** to **300**	OK ❑		
Flow_100ms	Displays **0** to **200**	OK ❑		
Oxygen	Displays as **Oxygen** "knob" ±5%	OK ❑		

TSW 11: Auto Zero Valves

dP Flow Sensor	Silver (ventilator side) connector closed, displays **-40** to **40** and **5040** to **5200**	OK ❑
	Blue (patient side) connector closed, displays **-40** to **40** and **-5040** to **-5200**	OK ❑
	Rinse flow check (with glass of water)	OK ❑

TSW 12: Safety Valve Block

Inspiratory valve airtightness check. Pressure <10 mbar (PN 155161) or < 4 mbar (PN 155491). OK ❑

Safety-valve-block airtightness check. Pressure decrease from 90 to 43 mbar >10 seconds. OK ❑

TSW 13: Ambient Valve

Ambient valve open:

Ppat displays **0** to **-20**	OK ❑	You can inhale	OK ❑	You cannot exhale	OK ❑

Ambient valve closed:

You cannot inhale	OK ❑

TSW 14: Servo and Flow Sensor

20ml/s	Pressure on gauge = pressure marked on capillary tube ±3 mbar	OK ❑
500ml/s	Corrected pressure on gauge = pressure marked on capillary tube ±2 mbar	OK ❑
	Flow Sensor calibrates correctly	OK ❑
Cal Status	Displays **0**	OK ❑
Flow pat	Values in range during inspiration-valve check	OK ❑
Ppat	Values in range during inspiration-valve check	OK ❑

TSW 15: Expiration Valve

Calibrate exp. valve Correctly calibrates valve OK ❑

Cal Status	Displays **0**	OK ❑
Paw	Displays values in range for PEEP/CPAP settings	OK ❑
Ppat	Displays values in range for PEEP/CPAP settings	OK ❑

TSW 16: Nebulizer

Paux	Displays < **35.0** after 10 s	OK ❑
Nebulizer pressure at gauge > 800 mbar		OK ❑
Nebulizer valve and compressor switch on and off correctly		OK ❑
Ptank	Displays **150** to **350**	OK ❑

Preoperational check OK ❑

3-month check OK ❑

GALILEO Upgrade 2 Test Report

Name:	....
Date (YYYY/MM/DD):	_ _ _ _ /_ _ /_ _
GALILEO serial number:	_ _ _ _
Service Manual version:	610207/ _ _

Instructions:
1. Enter information on dotted lines.
2. Check (tick) check boxes if function correct.

General Maintenance

	Yes	No
3 V real-time clock battery replaced	❑	❑
Oxygen cell replaced	❑	❑
Fan filter cleaned or replaced	❑	❑
Gas inlet filters replaced	❑	❑
Nebulizer overhauled (using kit)	❑	❑
LCD display backlight replaced	❑	❑
Backup batteries in column replaced	❑	❑

Test 1, *Microprocessor checks*

GMP ver: . . . .
Software checksum: Displays **OK** OK ❑

GCP ver: . . . .
Controlboard rev.

GPT ver: . . . .

GIP ver: . . . .

BIOS ver: . . . .

Date: . . . .
Operating hours: . . . .

OS ver: . . . .
Int. temp. In range OK ❑

Test 2, *GPT–GMP communication & LED checks*

Selftest: Displays **4** OK ❑
Incremented val: Increments OK ❑

GPT-GMP increm. test: Displays **Done** OK ❑
GPT-GMP interr test: Displays **Done** OK ❑

LED On/Off OK ❑
LED Flash/Off OK ❑
LED brightness OK ❑
Emergency alarm OK ❑
Relay On/Off OK ❑

Test 3, *LCD display checks*

All colors function	OK ❑
Max. 4 grouped bad pixels	OK ❑
Backlight switches on/off	OK ❑

VGA board ver: ....

VGA-BIOS ver: ....

Test 4, *User interface & alarmtone checks*

High alarm	OK ❑		
Medium alarm	OK ❑		
M - knob OK ❑	**C - knob** OK ❑	**Low alarm**	OK ❑

Alarm OK ❑ **100% O2** OK ❑ **MANUAL** OK ❑ **NEBULIZER** OK ❑

Test 5, *GCP–GMP communication checks*

DPRAM test:	Displays **OK**	OK ❑
GMP-GCP test:	Displays **OK**	OK ❑
GCP-GMP test:	Displays **OK**	OK ❑
DPRAM r/w test:	Displays **OK**	OK ❑

Selftest	Displays **0**	OK ❑
DPRAM collisions	Value in range	OK ❑
DDPRAM collisions	Value in range	OK ❑
Incremented val.	Increments	OK ❑

Test 6, *A/D converter check*

ADC 12	Displays **4850** to **5250**	OK ❑
ADC 14	Displays **-990** to **-1010**	OK ❑
ADC 15	Displays **990** to **1010**	OK ❑
ADC 16	Displays **-10** to **10**	OK ❑

Test 7, *D/A converter check*

ADC 9	All values in range	OK ❑
ADC 10	All values in range	OK ❑

Test 8, *Zero and full-scale calibration*

Ppat	Zero calibration OK ❑	Full-scale calibration OK ❑
Paw	Zero calibration OK ❑	Full-scale calibration OK ❑
Paux	Zero calibration OK ❑	Full-scale calibration OK ❑
dP Servo	Zero calibration OK ❑	Full-scale calibration OK ❑
dp mixer	Zero calibration OK ❑	
dP Flow Sensor	Zero calibration OK ❑	Full-scale check OK ❑

Test 9, *O2 cell calibration & check*

Calibrate O2 cell	Calibration	OK ❑
Tank gas	All fields in range	OK ❑
Inlet air	All fields in range	OK ❑
Inlet O2	All fields in range	OK ❑

Test 10, *Mixer calibration & checks*

Ptank	**300** to **280** mbar leak >8 s	OK ❑	Overpressure check <**500**	OK ❑
Ptank max	Displays **330** to **350**	OK ❑		
90ms flow	Displays **0** to **300**	OK ❑		
100ms flow	Displays **0** to **200**	OK ❑		
Oxygen	Display as **Oxygen** "knob" ±5%	OK ❑		

Test 11, *Flow Sensor circuit checks*

dP Flow Sensor	Silver (ventilator side) connector closed, displays **-40** to **40** and **5040** to **5200**	OK ❑
	Blue (patient side) connector closed, displays **-40** to **40** and **-5040** to **-5200**	OK ❑
	Rinse flow check (with glass of water)	OK ❑

Test 12, *Patient overpressure valve checks*

Inspiratory valve airtightness check. Pressure <10 mbar (PN 155161) or < 4 mbar (PN 155491).	OK ❑
Safety-valve-block airtightness check. Pressure decrease from 90 to 43 mbar >10 seconds.	OK ❑

Test 13, *Ambient valve check*

Ambient valve open:

Ppat displays **0** to **-20**	OK ❑	You can inhale	OK ❑	You cannot exhale	OK ❑

Ambient valve closed:

You cannot inhale	OK ❑

Test 14, *Inspiration valve check*

20ml/s	Pressure on gauge = pressure marked on capillary tube ±3 mbar	OK ❑
500ml/s	Corrected pressure on gauge = pressure marked on capillary tube ±2 mbar	OK ❑
	Flow Sensor calibrates correctly	OK ❑
Cal. status	Displays **0**	OK ❑
Flow pat	Values in range during inspiration-valve check	OK ❑
Ppat	Values in range during inspiration-valve check	OK ❑

Test 15, *Expiration valve calibrat. & check*

Calibrate exp. valve	Correctly calibrates valve	OK ❑
Cal. status	Displays **0**	OK ❑
Paw	Displays values in range for PEEP/CPAP settings	OK ❑
Ppat	Displays values in range for PEEP/CPAP settings	OK ❑

Test 16, *Nebulizer compressor check*

Paux	Displays < **35.0** after 10 s	OK ❑
Nebulizer pressure at gauge > 800 mbar		OK ❑
Nebulizer valve and compressor switch on and off correctly		OK ❑
Ptank	Displays **150** to **350**	OK ❑

Preoperational check	OK ❑
3-month check	OK ❑

Document History

Revision 01	October 1998. *Service Manual Addition*. This is the second part of the manual, only containing test software.
Revision 02	June 2002. *GALILEO Service Manual - maintenance and tests.* This is the second part of the manual, only containing test software. In this revision, the test software was split into *Original and Upgrade 1*, and *Upgrade 2*.
Revision 03	July 2003. *GALILEO Service Manual including maintenance, repairs and tests*. This is the first printing of the combined first and second parts of the manual.
Revision 04	This manual was not printed in Rev 04. This revision was only used for GALILEO Service Manual PN 610206, in which improvements were made to Section 2, *Pneumatics: components and theory of operation*.
Revision 05	October 2005. Complete rework and update of manual.

HAMILTON MEDICAL AG
Via Crusch 8
CH-7402 Bonaduz
Switzerland
Phone: (+41) 81 660 60 10
Fax: (+41) 81 660 60 20
International Web Site: www.hamilton-medical.com
USA Web Site: www.hammed1.com
Partner Web Site: www.hamilton-medical.com/partner-site
Intelligent Ventilation Website: www.IntelligentVentilation.org

HAMILTON MEDICAL
MAKING TECHNOLOGY SERVE MANKIND